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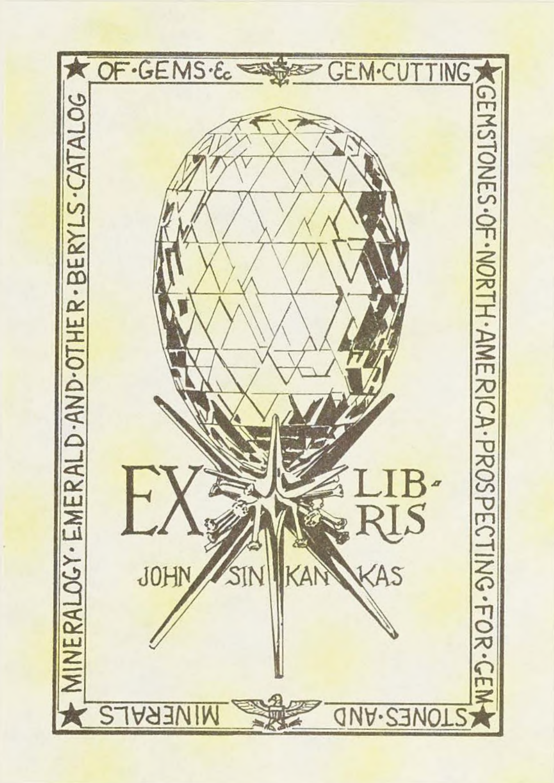

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VOL. XII.

INDOCTI DISCANT, ET AMENT MEMINISSE PERITI.

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Suppl. after p. 146

Names of Springs.	*Countries in which they are found.*	*Contents and Quality of the Water.*	*Medical Virtues.*
Tarleton,	Lancashire in England.	Similar to Scarborough water.	
Tewksbury,	Gloucestershire in England.	Similar to Acton.	
Thetford,	Norfolk in England.	Fossile alkali, fixed air, and iron.	Purgative and diuretic.
Thoroton,	Nottinghamshire in England.	Similar to Orston.	
Thursk,	Yorkshire in England.	Similar to Scarborough.	
Tibshelf,	Derbyshire in England.	Iron dissolved in fixed air.	Similar to Spaw water.
Tilbury,	Essex in England.	Fossile alkali.	Diuretic and diaphoretic.
Tober Bony,	Near Dublin in Ireland.	Fossile alkali, earth, and bituminous oil.	Similar to Tilbury.
Tonstein,	Cologne in Germany.	Fossile alkali.	Similar to Seltzer, but more purgative.
Tralee,	Kerry in Ireland.	Similar to Castle Connel.	
Tunbridge,	Kent in England.	Iron, some sea-salt, with a little selenites and calcareous earth.	An excellent chalybeate, useful in all diseases for which the Spaw is recommended.
Upminster,	Essex in England.	Sulphur, fossile alkali, and purging salt.	Purgative and diuretic.
Vahls,	Dauphiny in France.	Fossil alkali.	Diuretic and laxative.
Wardrew,	Northumberland.	Sulphur, earth, and sea-salt.	Similar to Harrowgate water.
Weatherstack,	Westmoreland in England.	Iron, sea-salt, and a small quantity of hepatic gas.	Purgative.
Wallenfrow,	Northamptonshire in England.	Similar to Islington water.	
West Ashton,	Wiltshire in England.	Similar to Islington.	
Westwood,	Derbyshire in England.	Green vitriol.	Similar to Shadwell. Used for washing ulcers of the legs.
Wexford,	Ireland.	Similar to Islington.	
Whiteacre,	Lancashire in England.	Aerated iron and probably calcareous earth.	Somewhat astringent.
Wigglesworth,	Yorkshire in England.	Sulphur, earth, and common salt.	Emetic in the quantity of two quarts, and said to be cathartic in the quantity of three; a singular circumstance if true.
Wildungan,	Waldech in Germany.	Similar to the waters of Bath.	Useful in scorbutic and gouty diseases.
Witham,	Essex in England.	Aerated iron, and common salt.	Diuretic, alterative, and corroborant.
Wirksworth,	Derbyshire in England.	Sulphur, purging salt, and aerated iron.	Useful in scrofulous and cutaneous diseases.
Zahorovice,	Germany.	Similar to Nezdenice water.	Much esteemed in scrofulous cases.

MINEHEAD, a town of Somersetshire, 166 miles from London. It is an ancient borough, with a harbour in the Bristol channel, near Dunster castle, much frequented by passengers to and from Ireland. It was incorporated by Queen Elisabeth, with great privileges, on condition the corporation should keep the quay in repair; but its trade falling off, the quay was neglected, and they lost their privileges. A statute was obtained in the reign of King William, for recovering the port, and keeping it in repair, by which they were to have the profits of the quay and pier for 36 years, which have been computed at about 200 l. a year; and they were at the expence of new-building the quay. In pursuance of another act, confirming the former, a new head has been built to the quay, the beach cleared, &c. so that the biggest ship may enter, and ride safe in the harbour. The town contains about 500 houses, and 2000 souls. It was formerly governed by a portreve, and now by two constables chosen yearly at a court-leet held by the lord of the manor. Its chief trade is with Ireland, from whence about 40 vessels used to come hither in a year with wool; and about 4000 chaldrons of coals are yearly imported at this place. Watchet and Poriock, from South Wales, which lies directly opposite to it, about seven leagues over, the common breadth of this channel all the way from Holmes to the Land's End. Here are several rich merchants, who have some trade also to Virginia and the West Indies; and they correspond much with the merchants of Barnestaple and Bristol in their foreign commerce. Three or four thousand barrels of herrings, which come up the Severn in great shoals about Michaelmas, are caught, cured, and shipped off here every year, for the Mediterranean, &c. The market here is on Wednesday, and fair on Whitsun-Wednesday.

MINERALOGY,

IS that fcience which teaches us the properties of mineral bodies, and by which we learn how to characterife, diftinguifh, and clafs them into a proper order.

INTRODUCTION.

MINERALOGY feems to have been in a manner coeval with the world. Precious ftones of various kinds appear to have been well known among the Jews and Egyptians in the time of Mofes; and even the moft rude and barbarous nations appear to have had fome knowledge of the ores of different metals. As the fcience is nearly allied to chemiftry, it is probable that the improvements both in chemiftry and mineralogy have nearly kept pace with each other; and indeed it is but of late, fince the principles of chemiftry were well underftood, that mineralogy has been advanced to any degree of perfection. The beft way of ftudying mineralogy, therefore, is by applying chemiftry to it; and not contenting ourfelves merely with infpecting the outfides of bodies, but decompounding them according to the rules of chemiftry. This method has been brought to the greateft perfection by Mr Pott of Berlin, and after him by Mr Cronftedt of Sweden. To obtain this end, chemical experiments in the large way are without doubt neceffary: but as a great deal of the mineral kingdom has already been examined in this manner, we do not need to repeat all thofe experiments in their whole extent, unlefs fome new and particular phenomena fhould difcover themfelves in thofe things we are examining; elfe the tedioufneffes of thofe proceffes might difcourage fome from going farther, and take up much of the time of others that might be better employed. An eafier way may therefore be adopted, which even for the moft part is fufficient, and which, though made in miniature, is as fcientifical as the common manner of proceeding in the laboratories, fince it imitates that, and is founded upon the fame principles. This confifts in making the experiments upon a piece of charcoal with the concentrated flame of a candle directed through a blow-pipe. The heat occafioned by this is very intenfe; and the mineral bodies may here be burnt, calcined, melted, and fcorified, &c. as well as in any great works.

For a defcription of the blow-pipe, the method of ufing it, the proper fluxes to be employed, and the different fubjects of examination to which that inftrument is adapted, fee the article *Blow-Pipe*, where all thofe particulars are concifely detailed. It may not be improper here, however, to refume thofe details at greater length; avoiding, at the fame time, all unneceffary repetitions. After which we fhall exhibit a fcientific arrangement of the mineral kingdom, according to the moft approved fyftem.

PART. I. EXPERIMENTAL MINERALOGY; with a DESCRIPTION of the NECESSARY APPARATUS (A).

SECT. I. *Of Experiments upon Earths and Stones.*

WHEN any of thefe fubftances are to be tried, we muft not begin immediately with the blow-pipe; but fome preliminary experiments ought to go before, by which thofe in the fire may afterwards be directed. For inftance, a ftone is not always homogeneous, or of the fame kind throughout, although it may appear to the eye to be fo. A magnifying glafs is therefore neceffary to difcover the heterogeneous particles, if there be any; and thefe ought to be feparated, and every part tried by itfelf, that the effects of two different things, examined together, may not be attributed to one alone. This might happen with fome of the finer micæ, which are now and then found mixed with fmall particles of quartz, fcarcely to be perceived by the eye. The trapp (in German *fchwartzftein*) is alfo fometimes mixed with very fine particles of feltfpar (*fpatum fcintillans*) or of calcareous fpar, &c. After this experiment, the hardnefs of the ftone in queftion muft be tried with fteel. The flint and garnets are commonly known to ftrike fire with fteel; but there are alfo other ftones, which, though very feldom, are found fo hard as likewife to ftrike fire. There is a kind of trapp of that hardnefs, in which no particles of feltfpar are to be feen. Coloured glaffes refemble true gems; but as they are very foft in proportion to thefe, they are eafily difcovered by means of the file. The common quartz-cryftals are harder than coloured glaffes, but fofter than the gems. The loadftone difcovers the prefence of iron, when it is not mixed in too fmall a quantity in the ftone, and often before the ftone is roafted. Some kinds of hæmatites, and particularly the cœrulefcens, greatly refemble fome other iron ores; but this diftinguifhes itfelf from them by a red colour when pounded, the others giving a blackifh powder, and fo forth.

The management of the *Blow-pipe* has been defcribed under that article; but a few particulars may be here recapitulated, or added.

The candle ought to be fnuffed often, but fo that the top of the wick may retain fome fat in it, becaufe the flame is not hot enough when the wick is almoft burnt to afhes; but only the top muft be fnuffed off, becaufe a low wick gives too fmall a flame. The blue flame is the hotteft; this ought, therefore, to be forced

(A) From Engeftrom's *Treatife on the Blow-Pipe*, and Magellan's *Defcription of Pocket-Laboratories*, &c. fubjoined to the Englifh Tranflation of *Cronftedt's Mineralogy*, 2d edit. in 2 vols. Dilly.

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forced out when a great heat is required, and only the point of the flame muſt be directed upon the ſubject which is to be eſſayed. M. Magellan recommends, as being moſt cleanly and convenient, that the candle be made of wax, and the wick ſhould be thicker than ordinary. Its upper end muſt be bended towards the matter intended to be heated, and the ſtream of air muſt be directed along the ſurface of the bended part, ſo as not abſolutely to touch it.

The piece of charcoal made uſe of in theſe experiments muſt not be of a diſpoſition to crack. If this ſhould happen, it muſt gradually be heated until it does not crack any more, before any aſſay is made upon it. If this be not attended to, but the aſſay made immediately with a ſtrong flame, ſmall pieces of it will ſplit off in the face and eyes of the aſſayer, and often throw along with them the matter that was to be aſſayed. Charcoal which is too much burnt conſumes too quick during the experiment, leaving ſmall holes in it, wherein the matter to be tried may be loſt; and charcoal that is burnt too little, catches flame from the candle, burning by itſelf like a piece of wood, which likewiſe hinders the proceſs.

Of thoſe things that are to be aſſayed, only a ſmall piece muſt be broken off for that purpoſe, not bigger than that the flame of the candle may be able to act upon it at once, if required; which is ſometimes neceſſary, as, when the matter requires to be made red hot throughout, the piece ought to be broken as thin as poſſible, at leaſt the edges; the advantage of which is obvious, the fire having then more influence upon the ſubject, and the experiment being more quickly made.

Some of the mineral bodies are very difficult to be kept ſteady upon the charcoal during the experiment, before they are made red hot; becauſe, as ſoon as the flame begins to act upon them, they ſplit aſunder with violence, and are diſperſed. Such often are thoſe which are of a ſoft conſiſtence or a particular figure, and which preſerve the ſame figure in however minute particles they are broken; for inſtance, the calcareous ſpar, the ſparry gypſum, ſparry fluor, white ſparry lead-ore, the potters ore, the teſſellated mock-lead or blende, &c. even all the common fluors which have no determinate figure. Theſe not being ſo compact as common hard ſtones, when the flame is immediately urged upon them, the heat forces itſelf through and into their clefts or pores, and cauſes this violent expanſion and diſperſion. Many of the clays are likewiſe apt to crack in the fire, which may be for the moſt part aſcribed to the humidity, of which they always retain a portion.

The only way of preventing this inconvenience is to heat the body as ſlowly as poſſible. It is beſt, firſt of all, to heat that place of the charcoal where the piece is intended to be put on; and afterwards lay it thereon: a little crackling will then enſue, but commonly of no great conſequence. After that, the flame is to be blown very ſlowly towards it, in the beginning not directly upon, but ſomewhat above it, and ſo approaching nearer and nearer with the flame until it become red hot. This will do for the moſt part; but there are nevertheleſs ſome, which, notwithſtanding all theſe precautions, it is almoſt impoſſible to keep on the charcoal. Thus the fluors are generally the moſt difficult; and as one of their principal characters is diſcovered by their effects in the fire *per ſe*, they ought neceſſarily to be tried that way. To this purpoſe, it is beſt to make a little hole in the charcoal to put the fluor in, and then to put another piece of charcoal as a covering upon this, leaving only a ſmall opening for the flame to enter. As this ſtone will nevertheleſs ſplit and fly about, a larger piece thereof than is before-mentioned muſt be taken, in order to have at leaſt ſomething of it left.

But if the experiment is to be made upon a ſtone whoſe effects one does not want to ſee in the fire *per ſe*, but rather with fluxes, then a piece of it ought to be forced down into melted borax, when always ſome part of it will remain in the borax, notwithſtanding the greateſt part may ſometimes fly away by cracking.

1. *Of ſubſtances to be tried in the fire* per ſe. As the ſtones undergo great alterations when expoſed to the fire by themſelves, whereby ſome of their characteriſticks, and often the moſt principal, are diſcovered, they ought firſt to be tried that way, obſerving what has been ſaid before concerning the quantity of matter, direction of the fire, &c. The following are generally the reſults of this experiment.

Calcareous earth or *ſtone*, when it is pure, does not melt by itſelf, but becomes white and friable, ſo as to break freely between the fingers; and, if ſuffered to cool, and then mixed with water, it becomes hot, juſt like common quick-lime. As in theſe experiments only very ſmall pieces are uſed, this laſt effect is beſt diſcovered by putting the proof on the outſide of the hand, with a drop of water to it, when inſtantly a very quick heat is felt on the ſkin. When the calcareous ſubſtance is mixed with the vitriolic acid, as in gypſum, or with a clay, as in marle, it commonly melts by itſelf, yet more or leſs difficultly in proportion to the differences of the mixtures. Gypſum produces generally a white, and marle a grey, glaſs or ſlag. When there is any iron in it, as a white iron ore, it becomes dark, and ſometimes quite black, &c.

The *ſiliceæ* never melt alone, but become generally more brittle after being burnt. Such of them as are coloured become colourleſs, and the ſooner when it does not ariſe from any contained metal; for inſtance, the topazes, amethiſts, &c. ſome of the precious ſtones, however, excepted: And ſuch as are mixed with a quantity of iron grow dark in the fire, as ſome of the jaſpers, &c.

Garnets melt always into a black ſlag, and ſometimes ſo eaſily that they may be brought into a round globule upon the charcoal.

The *argillaceæ*, when pure, never melt, but become white and hard. The ſame effects follow when they are mixed with phlogiſton. Thus the ſoap-rock is eaſily cut with the knife; but being burnt it cuts glaſs, and would ſtrike fire with the ſteel, if as large a piece as is neceſſary for that purpoſe could be tried in this way. The ſoap-rocks are ſometimes found of a dark brown and nearly black colour, but nevertheleſs become quite white in the fire like a piece of China ware. However, care muſt be taken not to urge the flame from the top of the wick, there being for the moſt part a ſooty ſmoke, which commonly will darken all that it touches; and, if this is not obſerved, a miſtake in the experiment might eaſily happen. But if

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it is mixed with iron, as it is sometimes found, it does not so easily part with its dark colour. The argillaceæ when mixed with lime melt by themselves, as abovementioned. When mixed with iron, as in the boles, they grow dark or black; and if the iron is not in too great a quantity, they melt alone into a dark flag; the same happens when they are mixed with iron and a little of the vitriolic acid, as in the common clay, &c.

Mica and *asbestos* become somewhat hard and brittle in the fire, and are more or less refractory, though they give some marks of fusibility.

The *fluors* discover one of their chief characteristics by giving a light like phosphorus in the dark, when they are slowly heated: but lose this property, as well as their colour, as soon as they are made red hot.—They commonly melt in the fire into a white opaque flag, though some of them not very easily.

Some sorts of the *zeolites* melt easily, and foam in the fire, sometimes nearly as much as borax, and become a frothy flag, &c.

A great many of those mineral bodies which are impregnated with iron, as the *boles*, and some of the white iron ores, &c. as well as some of the other iron ores, viz. the bloodstone, are not attracted by the loadstone before they have been thoroughly roasted, &c.

2. *Of substances heated with fluxes.* After the mineral bodies have been tried in the fire by themselves, they ought to be heated with fluxes to discover if they can be melted or not, and some other phenomena attending this operation. For this purpose, three different kinds of salts are used as fluxes, viz. sal sodæ, borax, and sal fusible microsmicum; (see the article *Blow-Pipe*).

The *sal sodæ* is, however, not much used in these small experiments, its effects upon the charcoal rendering it for the most part unfit for it; because, as soon as the flame begins to act upon it, it melts instantly, and is almost wholly absorbed by the charcoal. When this salt is employed to make any experiment, a very little quantity is wanted at once, viz. about the cubical contents of an eighth part of an inch, more or less. This is laid upon the charcoal, and the flame blown on it with the blow-pipe; but as this salt commonly is in form of a powder, it is necessary to go on very gently, that the force of the flame may not disperse the minute particles of the salt. As soon as it begins to melt, it runs along on the charcoal, almost like melted tallow; and when cold, it is a glassy matter of an opaque dull colour spread on the coal. The moment it is melted, the matter which is to be tried ought to be put into it, because otherwise the greatest part of the salt will be soaked into the charcoal, and too little of it left for the intended purpose. The flame ought then to be directed on the matter itself; and if the salt spreads too much about, leaving the proof almost alone, it may be brought to it again by blowing the flame on its extremities, and directing it towards the subject of the experiment. In the assays made with this salt, it is true, we may find whether the mineral bodies which are melted with it have been dissolved by it or not: but we cannot tell with any certitude whether this is done hastily and with force, or gently and slow; nor whether a less or a greater part of the matter has been dissolved: neither can it be well distinguished if the matter has imparted any weak tincture to the flag; because this salt always bubbles upon the charcoal during the experiment, nor is it clear when cool; so that scarcely any colour, except it be a vey deep one, can be discovered, although it may sometimes be coloured by the matter that has been tried.

The following earths are entirely *soluble* in this flux with effervescence: Agate; chalcedony; carnelian; Turkey stone †, (*cos Turcica*); fluor mineralis †; onyx; opal; quartz; common flint; ponderous spar. The following are *divisible* in it with or without effervescence, but not entirely soluble: Amianthus; asbestus; basaltes; chrysolite ‡; granate ‡; hornblende; jasper; marlstone; mica; the mineral of alum from Tolfa; petrosilex; aluminous slate and roof slate from Helsingia; emeralds; steatites; common flint; schoerl; talc; trapp; tripoli; tourmalin. And the following are neither fusible nor divisible in it: Diamond; hyacinth; ruby; sapphire; topaz.

The other two salts, viz. *borax* and the *sal microcosmicum*, are very well adapted to these experiments, because they may by the flame be brought to a clear uncoloured and transparent glass; and as they have no attraction to the charcoal, they keep themselves always upon it in a round globular form. The sal fusible microsmicum § is very scarce, and perhaps not to be met with in the shops; it is made of urine. § See *Chemistry*, n° 905, 906.

The following earths are soluble in borax, with more or less *effervescence*: Fluor mineralis †; marle; mica †; the mineral of alum from Tolfa; aluminous slate, and roof-slate from Helsingia †; ponderous spar; schoerl; talc †; tourmalin. And the following *without* effervescence; Agate; diamond; amianthus; asbestus; basaltes; chalcedony; cornelian; chrysolite; cos turcica; granate; hyacinth *; jasper; lapis ponderosus; onyx; opal; petro-silex; quartz *; ruby; sapphire; common flint *; steatite; trapp; trippel, or tripoli; topaz; zeolite; hydrophanes.

In the microcosmic salt, the following are soluble with more or less effervescence: Basaltes †; turkey stone ‡; fluor mineralis †; marle; mica; the mineral of alum from Tolfa; schistus aluminaris, schistus tegularis from Helsingia †; schoerl; spathum ponderosum; tourmalin †; lapis ponderosus. And the following without visible effervescence: Agate; diamond; amianthus; asbestus; chalcedony; carnelian; chrysolite; granate; hyacinth; jasper; onyx ‖; opal; petrosilex; quartz ‖; ruby; sapphire; common flint ‖; emerald; talc; topaz; trapp; trippel; zeolite; hornblend; hydrophanes; lithomarga; steatites.

Calcareous earth, ponderous spar, gypsum, and other additaments, often assist the solution, as well in the microcosmic salt as in borax. To which it is necessary to add, that in order to observe the effervescence properly, the matter added to the flux should be in the form of a small particle rather than in fine powder; because in this last there is always air between the particles, which being afterwards driven off by the heat afford the appearance of a kind of effervescence (A).

The

(A) In the above lists, the articles marked † effervesce very little; those marked ‡ not at all; those marked * require a larger quantity of the flux and a longer continuance of heat than the rest; those marked ‖ are more difficultly dissolved than the others.

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The quantity of those two salts required for an experiment is almost the same as the *sal sodæ*; but as the former are crystallised, and consequently include a great deal of water, particularly the borax, their bulk is considerably reduced when melted, and therefore a little more of them may be taken than the before-mentioned quantity.

Both those salts, especially the borax, when exposed to the flame of the blow-pipe, bubble very much and foam before they melt to a clear glass, which for the most part depends on the water they contain. And as this would hinder the assayer from making due observations on the phenomena of the experiment, the salt which is to be used must first be brought to a clear glass before it can serve as a flux; it must therefore be kept in the fire until it become so transparent that the cracks in the charcoal may be seen through it. This done, whatsoever is to be tried is put to it, and the fire continued.

Here it is to be observed, that for the assays made with any of these two fluxes on mineral bodies, no larger pieces must be taken than that altogether they may keep a globular form upon the charcoal; because it may then be better distinguished in what manner the flux acts upon the matter during the experiment. If this be not observed, the flux, communicating itself with every point of the surface of the mineral body, spreads all over it, and keeps the form of this last, which commonly is flat, and by that means hinders the operator observing all the phenomena which may happen. Besides, the flux being in too small a quantity in proportion to the body to be tried, will be too weak to act with all its force upon it. The best proportion therefore is about a third part of the mineral body to the flux; and as the quantity of the flux above mentioned makes a globe of a due size in regard to the greatest heat that is possible to procure in these experiments, so the size of the mineral body must be a third part less here than when it is to be tried in the fire by itself.

The *sal sodæ*, as has been already observed, is not of much use in these experiments; nor has it any particular qualities in preference to the two last mentioned salts, except that it dissolves the zeolites easier than they do.

The microcosmic salt shows almost the same effects in the fire as the borax, only differing from it in a very few circumstances; of which one of the principal is, that, when melted with manganese, it becomes of a crimson hue instead of a jacinth colour, which borax takes. This salt is, however, for its scarcity still very little in use, borax alone being that which is commonly employed. Whenever a mineral body is melted with any of these two last mentioned salts, in the manner already described, it is easily seen, Whether it quickly dissolves; in which case an effervescence arises, that lasts till the whole be dissolved: Whether the solution be slowly performed; in which case few and small bubbles only rise from the matter: or, Whether it can be dissolved at all; because, if not, it is observed only to turn round in the flux, without the least bubble, and the edges look as sharp as they were before.

In order farther to illustrate what has been said about these experiments, we shall give a few examples of the effects of borax upon the mineral bodies.—The *calcareous* substances, and all those stones which contain any thing of lime in their composition, dissolve readily and with effervescence in the borax. The effervescence is the more violent the greater the portion of lime contained in the stone. This cause, however, is not the only one in the gypsum, because both the constituents of this do readily mix with the borax, and therefore a greater effervescence arises in melting gypsum with the borax than lime alone.—The *siliceæ* do not dissolve; some few excepted which contain a quantity of iron.—The *argillaceæ*, when pure, are not acted upon by the borax: but when they are mixed with some heterogeneous bodies, they are dissolved, though very slowly; such are, for instance, the stone-marrow, the common clay, &c.

The *granates*, *zeolites*, and *trapp*, dissolve but slowly. The *fluors*, *asbestinæ*, and *micaceæ*, dissolve for the most part very easily; and so forth.—Some of these bodies melt to a colourless transparent glass with the borax; for instance, the calcareous substances when pure, the fluors, some of the zeolites, &c. Others tinge the borax with a green transparent colour, *viz.* the granates, trapp, some of the argillaceæ, and some of the micaceæ and asbestinæ. This green has its origin partly from a small portion of iron which the granates particularly contain, and partly from phlogiston.

Borax can only dissolve a certain quantity of the mineral body proportional to its own. Of the calcareous kind it dissolves a vast quantity; but turns at last, when too much has been added, from a clear transparent to a white opaque slag. When the quantity of the calcareous matter exceeds but little in proportion, the glass looks very clear as long as it remains hot: but as soon as it begins to cool, a white half opaque cloud is seen to arise from the bottom, which spreads over the third, half, or more of the glass globe, in proportion to the quantity of calcareous matter; but the glass or slag is nevertheless shining, and of a glassy texture when broken. If more of this matter be added, the cloud rises quicker and is more opaque, and so by degrees till the slag becomes quite milk white. It is then no more of a shining, but rather dry appearance, on the surface; is very brittle, and of a grained texture when broken.

SECT. II. *Of Experiments upon Metals and Ores.*

WHAT has been hitherto said relates only to the *stones* and *earths*: We shall now proceed to describe the manner of examining *metals* and *ores*. An exact knowledge and nicety of procedure are so much the more necessary here, as the metals are often so disguised in their ores, as to be very difficultly known by their external appearance, and liable sometimes to be mistaken one for the other: Some of the cobalt ores, for instance, resemble much the *pyrites arsenicalis*; there are also some iron and lead ores, which are nearly like one another, &c.

As the ores generally consist of metals mineralised with sulphur or arsenic, or sometimes both together, they ought first to be exposed to the fire by themselves, in order not only to determine with which of these they are mineralised, but also to set them free from those volatile mineralising bodies: This serves instead of calcination, by which they are prepared for further assays.

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Here it muſt be repeated, that whenever any metal or fuſible ore is to be tried, a little concavity muſt be made in that place of the charcoal where the matter is to be put; becauſe, as ſoon as it is melted, it forms itſelf into a globular figure, and might then roll from the charcoal, if its ſurface was plain; but when borax is put to it, this inconvenience is not ſo much to be feared.

Whenever an ore is to be tried, a ſmall bit being broke off for the purpoſe, it is laid upon the charcoal, and the flame blown on it ſlowly. Then the ſulphur or arſenic begins to part from it in form of ſmoke: theſe are eaſily diſtinguiſhed from one another by their ſmell; that of ſulphur being ſufficiently known, and the arſenic ſmelling like garlick. The flame ought to be blown very gently as long as any ſmoke is ſeen to part from the ore; but after that, the heat muſt be augmented by degrees, in order to make the calcination as perfect as poſſible. If the heat be applied very ſtrongly from the beginning upon an ore that contains much ſulphur or arſenic, the ore will preſently melt, and yet loſe very little of its mineraliſing bodies, by that means rendering the calcination very imperfect. It is, however, impoſſible to calcine the ores in this manner to the utmoſt perfection, which is eaſily ſeen in the following inſtance, *viz.* in melting down a calcined potter's ore with borax, it will be found to bubble upon the coal, which depends on the ſulphur which is ſtill left, the vitriolic acid of this uniting with the borax, and cauſing this motion. However, lead in its metallic form, melted in this manner, bubbles upon the charcoal, if any ſulphur remains in it. But as the lead, as well as ſome of the other metals, may raiſe bubbles upon the charcoal, although they are quite free from the ſulphur, only by the flames being forced too violently on it, theſe phenomena ought not to be confounded with each other.

The ores being thus calcined, the metals contained in them may be diſcovered, either by being melted alone or with fluxes; when they ſhow themſelves either in their pure metallic ſtate, or by tinging the ſlag with a colour peculiar to each of them. In theſe experiments it is not to be expected that the quantity of metal contained in the ore ſhould be exactly determined; this muſt be done in larger laboratories. This cannot, however, be looked upon as any defect, ſince it is ſufficient for a mineralogiſt only to find out what ſort of metal is contained in the ore. There is another circumſtance, which is a more real defect in the miniature laboratories, which is, that ſome ores are not at all capable of being tried by ſo ſmall an apparatus; for inſtance, the gold ore called *pyrites aureus*, which conſiſts of gold, iron, and ſulphur. The greateſt quantity of gold which this ore contains is about one ounce, or one ounce and an half, out of 100 pounds of the ore, the reſt being iron and ſulphur: and as only a very ſmall bit is allowed for theſe experiments, the gold contained therein can hardly be diſcerned by the eye, even if it could be extracted; but it goes along with the iron in the ſlag, this laſt metal being in ſo large a quantity in proportion to the other, and both of them having an attraction for each other.

The blendes and black-jacks, which are mineral zinc ores, containing zinc, ſulphur, and iron, cannot be tried this way, becauſe they cannot be perfectly calcined, and beſides the zinc flies off when the iron ſcorifies. Neither can thoſe blendes, which contain ſilver or gold mineraliſed with them, be tried in this manner, which is particularly owing to the imperfect calcination. Nor are the quickſilver ores fit for theſe experiments; the volatility of that ſemimetal making it impoſſible to bring it out of the poorer ſort of ores; and the rich ores, which ſweat out the quickſilver when kept cloſe in the hand, not wanting any of theſe aſſays, &c. Thoſe ores ought to be aſſayed in larger quantities, and even with ſuch other methods as cannot be applied upon a piece of charcoal.

Some of the rich ſilver ores are eaſily tried: for inſtance, *minera argenti vitrea*, commonly called *ſilver-glaſs*, which conſiſts only of ſilver and ſulphur. When this ore is expoſed to the flame, it melts inſtantly, and the ſulphur goes away in fume, leaving the ſilver pure upon the charcoal in a globular form. If this ſilver ſhould happen to be of a dirty appearance, which often is the caſe, then it muſt be melted anew with a very little borax; and after it has been kept in fuſion for a minute or two, ſo as to be perfectly melted and red-hot, the proof is ſuffered to cool: it may then be taken off the coal; and being laid upon the ſteel-plate†, the ſilver is ſeparated from the ſlag by one or two ſtrokes of the hammer†. Here the uſe of the braſs ring† is manifeſt; for this ought firſt to be placed upon the plate, to hinder the proof from flying off by the violence of the ſtroke, which otherwiſe would happen. The ſilver is then found incloſed in the ſlag of a globular form, and quite ſhining, as if it was poliſhed. When a large quantity of ſilver is contained in a lead ore, *viz.* in a potter's ore, it can likewiſe be diſcovered through the uſe of the blow-pipe, of which more will be mentioned hereafter.

† See the article Blow-*Pipe*, and Plate XCIX.

Tin may be melted out of the pure tin ores in its metallic ſtate. Some of theſe ores melt very eaſily, and yield their metal in quantity, if only expoſed to the fire by themſelves: but others are more refractory; and as theſe melt very ſlowly, the tin, which ſweats out in form of very ſmall globules, is inſtantly burnt to aſhes before theſe globules have time to unite in order to compoſe a larger globe, which, might be ſeen by the eye, and not ſo ſoon deſtroyed by the fire; it is therefore neceſſary to add a little borax to theſe from the beginning, and then to blow the flame violently at the proof. The borax does here preſerve the metal from being too ſoon calcined, and even contributes to the readier collecting of the ſmall metallic particles, which ſoon are ſeen to form themſelves into a globule of metallic tin at the bottom of the whole maſs, neareſt to the charcoal. As ſoon as ſo much of the metallic tin is produced as is ſufficient to convince the operator of its preſence, the fire ought to be diſcontinued, though the whole of the ore be not yet melted; becauſe the whole of this kind of ore can be ſeldom or never reduced into metal by means of theſe experiments, a great proportion being always calcined: and if the fire is continued too long, perhaps even the metal already reduced may likewiſe be burnt to aſhes; for the tin is very ſoon deprived of its metallic ſtate by the fire.

Moſt part of the lead ores may be reduced to a metallic ſtate upon the charcoal. The *mineræ plumbi calciformes*, which are pure, are eaſily melted into lead;

but ſuch of them as are mixed with an *ochra ferri*, or any kind of earth, as clay, lime, &c. yield very little of lead, and even nothing at all, if the heterogenea are combined in any large quantity: this happens even with the *minera plumbi calciformis arſenico mixta*. Theſe therefore are not to be tried but in larger laboratories. However, every mineral body ſuſpected to contain any metallic ſubſtance may be tried by the blow-pipe, ſo as to give ſufficient proofs whether it contain any or not, by its effects being different from thoſe of the ſtones or earths, &c.

The *mineræ plumbi mineraliſatæ* leave the lead in a metallic form, if not too large a quantity of iron is mixed with it. For example, when a teſſellated or ſteel-grained lead ore is expoſed to the flame, its ſulphur, and even the arſenic if there be any, begins to fume, and the ore itſelf immediately to melt into a globular form; the reſt of the ſulphur continues then to fly off, if the flame be blown ſlowly upon the maſs; but, on the contrary, very little of the ſulphur will go off, if the flame be forced violently on it: in this caſe, it rather happens that the lead itſelf crackles and diſſipates, throwing about very minute metallic particles. The ſulphur being driven out as much as poſſible, which is known by finding no ſulphureous vapour in ſmelling at the proof, the whole is ſuffered to cool, and then a globule of metallic lead will be left upon the coal. If any iron is contained in the lead-ore, the lead, which is melted out of it, is not of a metallic ſhining, but rather of a black and uneven, ſurface: a little borax muſt in this caſe be melted with it, and as ſoon as no bubble is ſeen to riſe any longer from the metal into the borax, the fire muſt be diſcontinued: when the maſs is grown cold, the iron will be found ſcorified with the borax, and the lead left pure and of a ſhining colour.

Borax does not ſcorify the lead in theſe ſmall experiments when it is pure: if the flame is forced with a violence on it, a bubbling will enſue, reſembling that which is obſerved when borax diſſolves a body melted with it; but when the fire ceaſes, the ſlag will be perfectly clear and tranſparent, and a quantity of very minute particles of lead will be ſeen ſpread about the borax, which have been torn off from the maſs during the bubbling.

If ſuch a lead ore is rich in ſilver, this laſt metal may likewiſe be diſcovered by this experiment; becauſe as the lead is volatile, it may be forced off, and the ſilver remain. To effect this, the lead, which is melted out of the ore, muſt be kept in conſtant fuſion with a ſlow heat, that it may be conſumed. This end will be ſooner obtained, and the lead part quicker, if during the fuſion the wind through the blow-pipe be directed immediately, though not forcibly, upon the melted maſs itſelf, until it begin to cool; at which time the fire muſt be directed on it again. The lead, which is already in a volatiliſing ſtate, will by this artifice be driven out in form of a ſubtil ſmoke; and by thus continuing by turns to melt the maſs, and then to blow off the lead, as has been ſaid, until no ſmoke is any longer perceived, the ſilver will at laſt be obtained pure. The ſame obſervation holds good here alſo, which was made about the gold, that, as none but very little bits of ores can be employed in theſe experiments, it will be difficult to extract the ſilver out of a poor ore; for ſome part of it will fly off with the lead, and what might be left is too ſmall to be diſcerned by the eye. The ſilver, which by this means is obtained, is eaſily diſtinguiſhed from lead by the following external marks, *viz.* that it muſt be red-hot before it can be melted: it cools ſooner than lead: it has a ſilver colour; that is to ſay, brighter and whiter than lead: and is harder under the hammer.

The *mineræ cupri calciformes* (at leaſt ſome of them), when not mixed with too much ſtone or earth, are eaſily reduced to copper with any flux; if the copper is found not to have its natural bright colour, it muſt be melted with a little borax, which purifies it. Some of theſe ores do not all diſcover their metal if not immediately melted with borax; the heterogenea contained in them hindering the fuſion before theſe are ſcorified by the flux.

The grey copper ores, which only conſiſt of copper and ſulphur, are tried almoſt in the ſame manner as above mentioned. Being expoſed to the flame by themſelves, they will be found inſtantly to melt, and part of their ſulphur to go off. The copper may afterwards be obtained in two ways: the one, by keeping the proof in fuſion for about a minute, and afterwards ſuffering it to cool; when it will be found to have a dark and uneven appearance externally, but which after being broken diſcovers the metallic copper of a globular form in its centre, ſurrounded with a regulus, which ſtill contains ſome ſulphur and a portion of the metal: the other, by being melted with borax, which laſt way ſometimes makes the metal appear ſooner.

The *mineræ cupri pyritaceæ*, containing copper, ſulphur, and iron, may be tried with the blow-pipe if they are not too poor. In theſe experiments the ore ought to be calcined, and after that the iron ſcorified. For this purpoſe a bit of the ore muſt be expoſed to a ſlow flame, that as much of the ſulphur as poſſible may part from it before it is melted, becauſe the ore commonly melts very ſoon, and then the ſulphur is more difficultly driven off. After being melted, it muſt be kept in fuſion with a ſtrong fire for about a minute, that a great part of the iron may be calcined; and after that, ſome borax muſt be added, which ſcorifies the iron, and turns with it to a black ſlag. If the ore is very rich, metallic copper will be had in the ſlag after the ſcorification. If the ore be of a moderate richneſs, the copper will ſtill retain a little ſulphur, and ſometimes iron: the product will therefore be brittle, and muſt with great caution be ſeparated from the ſlag, that it may not break into pieces; and if this product is afterwards treated in the ſame manner as before ſaid, in ſpeaking of the grey copper-ores, the metal will ſoon be produced. But if the ore is poor, the product after the firſt ſcorification muſt be brought into fuſion, and afterwards melted with ſome freſh borax, in order to calcine and ſcorify the remaining portion of iron; after which it may be treated as mentioned in the preceding paragraph. The copper will in this laſt caſe be found in a very ſmall globule.

The copper is not very eaſily ſcorified with this apparatus, when it is melted together with borax, unleſs it has firſt been expoſed to the fire by itſelf for a while in order to be calcined. When only a little of this metal is diſſolved, it inſtantly tinges the ſlag of a red-

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dish brown colour, and mostly opaque; but as soon as this slag is kept in fusion for a little while, it becomes quite green and transparent: and thus the presence of the copper may be discovered by the colour, when it is concealed in heterogeneous bodies, so as not to be discovered by any other experiment.

If metallic copper is melted with borax by a slow fire, and only for a very little time, the glass or slag becomes of a fine transparent blue or violet colour, inclining more or less to the green: but this colour is not properly owing to the copper, but it may rather be to its phlogiston; because the same colour is to be had in the same manner from iron; and these glasses, which are coloured with either of those two metals, soon lose their colour if exposed to a strong fire, in which they become quite clear and colourless. Besides, if this glass, tinged blue with the copper, is again melted with more of this metal, it becomes of a good green colour, which for a long time keeps unchanged in the fire.

The iron ores, when pure, can never be melted *per se*, by the means of the blow-pipe alone; nor do they yield their metal when melted with fluxes; because they require too strong a heat to be brought into fusion; and as both the ore and the metal itself very soon lose their phlogiston in the fire, and cannot be supplied with a sufficient quantity from the charcoal, so likewise they are very soon calcined in the fire. This easy calcination is also the reason why the fluxes, for instance borax, readily scorify this ore, and even the metal itself. The iron loses its phlogiston in the fire sooner than the copper, and is therefore more easily scorified.

The iron is, however, discovered without much difficulty, although it were mixed but in a very small quantity with heterogeneous bodies. The ore, or those bodies which contain any large quantity of the metal, are all attracted by the loadstone, some without any previous calcination, and others without having being roasted. When a clay is mixed with a little iron, it commonly melts by itself in the fire; but if this metal is contained in a limestone, it does not promote the fusion, but gives the stone a dark and sometimes a deep black colour, which always is the character of iron. A *minera ferri calciformis pura crystallisata*, is commonly of a red colour: This being exposed to the flame, becomes quite black; and is then readily attracted by the loadstone, which it was not before. Besides these signs, the iron discovers itself, by tinging the slag of a green transparent colour, inclining to brown, when only a little of the metal is scorified; but as soon as any larger quantity thereof is dissolved in the slag, this becomes first a blackish brown, and afterwards quite black and opaque.

Bismuth is known by its communicating a yellowish brown colour to borax; and arsenic by its volatility and garlick smell. Antimony, both in form of regulus and ore, is wholly volatile in the fire when it is not mixed with any other metal except arsenic; and is known by its particular smell, easier to be distinguished when once known than described. When the ore of antimony is melted upon the charcoal, it bubbles constantly during its volatilising.

Zinc ores are not easily tried upon the coal; but the regulus of zinc exposed to the fire upon the charcoal burns with a beautiful blue flame, and forms itself almost instantly into white flowers, which are the common flowers of zinc.

Cobalt is particularly remarkable for giving to the glass a blue colour, which is the zaffre or smalt. To produce this, a piece of cobalt ore must be calcined in the fire, and afterwards melted with borax. As soon as the glass, during the fusion, from being clear, seems to grow opaque, it is a sign that it is already tinged a little; the fire is then to be discontinued, and the operator must take hold, with the nippers, of a little of the glass, whilst yet hot, and draw it out slowly in the beginning, but afterwards very quick, before it cools, whereby a thread of the coloured glass is procured, more or less thick, wherein the colour may easier be seen than in a globular form. This thread melts easily, if only put in the flame of the candle without the help of the blow-pipe.—If this glass be melted again with more of the cobalt, and kept in fusion for a while, the colour becomes very deep; and thus the colour may be altered at pleasure.

When the cobalt ore is pure, or at least contains but little iron, a cobalt regulus is almost instantly produced in the borax during the fusion; but when it is mixed with a quantity of iron, this last metal ought first to be separated, which is easily performed since it scorifies sooner than the cobalt; therefore, as long as the slag retains any brown or black colour, it must be separated, and melted again with fresh borax, until it shows the blue colour.

Nickel is very seldom to be had; and as its ores are seldom free from mixtures of other metals, it is very difficultly tried with the blow-pipe. However, when this semimetal is mixed with iron and cobalt, it is easily freed from these heterogeneous metals, and reduced to a pure nickel regulus by means of scorification with borax, because both the iron and cobalt sooner scorify than the nickel. The regulus of nickel itself is of a green colour when calcined: it requires a pretty strong fire before it melts, and tinges the borax with a hyacinth colour. Manganese gives the same colour to borax; but its other qualities are quite different, so as not be confounded with the nickel.

By means of the foregoing explanations, and those given under the article *Blow-Pipe*, any gentleman, who is a lover of this science, will be able, in an easy manner, to amuse himself in discovering the properties of those works of nature, with which the mineral kingdom furnishes us; or more usefully to employ himself by finding out what sorts of stones, earths, ores, &c. there are on his estate, and to what economical purposes they may be employed. The scientific mineralist may, by examining into the properties and effects of the mineral bodies, discover the natural relation these bodies stand in to each other, and thereby furnish himself with materials for establishing a mineral system, founded on such principles as Nature herself has laid down in them; and this in his own study, without being forced to have recourse to great laboratories, crucibles, furnaces, &c. which is attended with much trouble, and is the reason why so few can have an opportunity of gratifying their desire of knowledge in this

Portable Apparatus. this part of natural hiftory. Farther improvements of this apparatus may ftill be made by thofe who choofe to beftow their attention upon it.

A great number of fluxes might, perhaps, be found out, whofe effects might be different from thofe already in ufe, whereby more diftinct characters of thofe mineral bodies might be difcovered, which now either fhow ambiguous ones, or which it is almoft impoffible to try exactly with the blowpipe. Inftead of the *fal fodæ*, fome other falt might be difcovered better adapted to thefe experiments. But it is very neceffary not to make ufe of any other fluxes on the charcoal than fuch as have no attraction to it: if they, at the fame time, be clear and tranfparent, when melted, as the borax and the *fal fufibile microcofmicum*, it is ftill better: however, the tranfparency and opacity are of no great confequence, if a fubftance be effayed only in order to difcover its fufibility, without any attention to its colour; in which cafe, fome metallic flag, perhaps, might be ufeful.

When fuch ores are to be reduced whofe metals are very eafily calcined, as tin, zinc, &c. it might perhaps be of fervice to add fome phlogiftic body, fuch as hard refin, fince the charcoal cannot afford enough of it in the open fire of thefe effays. The manner of melting the volatile metals out of their ores *per defcenfum* might alfo, perhaps, be imitated: for inftance, a hole might be made in the charcoal, wide above and very narrow at the bottom; a little piece of the ore being then laid at the upper end of the hole, and covered with fome very fmall pieces of the charcoal, the flame muft be directed on the top: the metal might, perhaps, by this method, run into the hole below, concealed from the violence of the fire, particularly if the ore is very fufible, &c.

The ufe of the apparatus above referred to, and which may be called a *pocket laboratory* (as the whole admits of being eafily packed into a fmall cafe), is chiefly calculated for a travelling mineralift. But a perfon who always refides at one and the fame place, may by fome alteration make it more commodious to himfelf, and avoid the trouble of blowing with the mouth. For this purpofe he may have the blow-pipe go through a hole in a table, and fixed underneath to a fmall pair of bellows with double bottoms, fuch as fome of the glafs-blowers ufe, and then nothing more is required than to move the bellows with the feet during the experiment; but in this cafe a lamp may be ufed inftead of a candle. This method would be attended with a ftill greater advantage, if there were many fuch parts as *c*, fig. 13. the openings of which were of different dimenfions: thofe parts might by means of a fcrew be faftened to the main body of the blow-pipe, and taken away at pleafure. The advantage of having thefe nozzles of different capacities at their ends, would be that of exciting a ftronger or weaker heat as occafion might require. It would only be neceffary to obferve, that in proportion as the opening or nozzle of the pipe is enlarged, the quantity of the flame muft be augmented by a thicker wick in the lamp, and the force of blowing encreafed by means of weights laid on the bellows; a much intenfer heat would thus be produced by a pipe of a confiderable opening at the end, by which the experiments muft undoubtedly be carried farther than the common blow-pipe.

Plate CCCXIII.

A traveller, who has feldom an opportunity of carrying many things along with him, may very well be contented with this laboratory and its apparatus, which are fufficient for moft part of fuch experiments as can be made on a journey. There are, however, other things very ufeful to have at hand on a journey, which ought to make a feparate part of a portable laboratory, if the manner of travelling does not oppofe it: this confifts of a little box including the different acids, and one or two matraffes, in order to try the mineral bodies in liquid menftrua if required.

Thefe acids are, the acid of nitre, of vitriol, and of common falt. Moft of the ftones and earths are attacked, at leaft in fome degree, by the acids; but the calcareous are the eafieft of all to be diffolved by them, which is accounted for by their calcareous properties. The acid of nitre is that which is moft ufed in thefe experiments; it diffolves the limeftone, when pure, perfectly, with a violent effervefcence, and the folution becomes clear: when the limeftone enters into fome other body, it is neverthelefs difcovered by this acid, through a greater or lefs effervefcence in proportion to the quantity of the calcareous particles, unlefs there are fo few as to be almoft concealed from the acid by the heterogeneous ones. In this manner a calcareous body, which fometimes nearly refembles a filiceous or argillaceous one, may be known from thefe latter, without the help of the blow-pipe, only by pouring one or two drops of this acid upon the fubject; which is very convenient when there is no opportunity nor time of ufing this inftrument.

The gypfa, which confift of lime and the vitriolic acid, are not in the leaft attacked by the acid of nitre, if they contain a fufficient quantity of their own acid; becaufe the vitriolic acid has a ftronger attraction to the lime than the acid of nitre: but if the calcareous fubftance is not perfectly faturated with the acid of vitriol, then an effervefcence arifes with the acid of nitre, more or lefs in proportion to the want of the vitriolic acid. Thefe circumftances are often very effential in diftinguifhing the *calcarea* and *gypfa* from one another.

The acid of nitre is likewife neceffary in trying the zeolites, of which fome fpecies have the fingular effect to diffolve with effervefcence in the above mentioned acid; and within a quarter of an hour, or even fometimes not until feveral hours after, to change the whole folution into a clear jelly, of fo firm a confiftence, that the glafs wherein it is contained may be reverfed without its falling out.

If any mineral body is tried in this menftruum, and only a fmall quantity is fufpected to be diffolved, though it was impoffible to diftinguifh it with the eye during the folution, it can be eafily difcovered by adding to it *ad faturitatem* a clear folution of the alkali, when the diffolved part will be precipitated, and fall to the bottom. For this purpofe the *fal fodæ* may be very ufeful.

The acid of nitre will fuffice for making experiments upon ftones and earths; but if the experiments are to be extended to the metals, the other two acids are alfo neceffary.

Another inftrument is likewife neceffary to a complete

Portable Apparatus.

complete Pocket-Laboratory, viz. a washing-trough (fig. 21.), in which the mineral bodies, and particularly the ores, may be separated from each other, and from the adherent rock, by means of water. This trough is very common in laboratories, and is used of different sizes; but here only one is required of a moderate size, such as 12 inches and a half long, three inches broad at the one end and one inch and a half at the other end, sloping down from the sides and the broad end to the bottom, where it is three quarters of an inch deep. It may, however, be made of much smaller dimensions. It is commonly made of wood, which ought to be chosen smooth, hard, and compact, wherein are no pores in which the minute grains of the pounded matter may conceal themselves. It is to be observed, that if any such matter is to be washed as is suspected to contain some native metal, such as silver or gold, a trough should be procured for this purpose of a very shallow slope; because the minute particles of the native metal have then more power to assemble together at the broad end, and separate from the other matter.

The management of this trough, or the manner of washing, consists in this: That when the matter is mixed with about three or four times its quantity of water in the trough, this is kept very loose between two fingers of the left hand, and some light strokes given on its broad end with the right, that it may move backwards and forwards; by which means the heaviest particles assemble at the broad and lower end, from which the lighter ones are to be separated by inclining the trough and pouring a little water on them. By repeating this process, all such particles as are of the same gravity may be collected together, and separated from those of different gravity, provided they were before equally pounded: though such as are of a clayey nature, are often very difficult to separate from the rest, which, however, is of no great consequence to a skilful and experienced washer. The washing process is very necessary, as there are often rich ores, and even native metals, found concealed in earths and sand in such minute particles as not to be discovered by any other means.

Sect. III. *Description of an Improved Portable Laboratory for assaying Minerals.*

The chief pieces and implements of the portable laboratories are represented in Plate XCIX. at *Blow-Pipe*, and in Plate CCCXIII. annexed to the present article.

I. The first contains those belonging to the *Dry* Laboratory, so called on account of its containing whatever is required to try all kinds of fossils in the dry way by fire, without any of the humid menstruums. They are made to pack in a box of the size of an octavo book, lined with green velvet, and covered with black fish-skin; the inside divided into different compartments, suited to the size, form, and number of the implements it is to contain. Of these the principal are described under *Blow-Pipe*. We must here, however, add the following remarks and alterations of that instrument by Mr Magellan.

Plate CCCXIII.

D and Q (fig. 13.) are the two pieces that form the blow-pipe, which is here represented entire. This very useful instrument has been considerably improved of late in England. The mouth-piece *aa* is made of ivory, to avoid the disagreeable sensation of having a piece of metal a long time between the teeth and lips, which, if not of silver or gold, may be very noxious to the operator; a circumstance that has been hardly noticed before.

1. If the mouth-piece *aa* be made of a round form, it cannot be held for any length of time between the teeth and lips, to blow through it, without straining the muscles of the mouth, which produces a painful sensation. It must, therefore, have such an external figure, as to adapt itself accurately to the lateral angles of the lips, having a flattish oval form externally, with two opposite corners to fit those internal angles of the mouth, when it is held between the lips, as may be seen in that represented in the figure.

2. The small globe *bb* is hollow, for receiving the moisture of the breath; and must be composed of two hemispheres, exactly screwing into one another in *bb*; the male-screw is to be in the lower part, and soldered on the crooked part Q of the tube Q D, at such a distance, that the inside end of the crooked tube be even with the edge of the hemisphere, as represented by the pointed lines in the figure. But the upper hemisphere is to be soldered at the end of the straight tube D. By these means, the moisture arising from the breath falls into the hollow of the lower hemisphere, where it is collected round the upper inside end of the crooked part Q of the blow-pipe, without being apt to fall into it.

3. The small nozzles, or hollow conical tubes, advised by Messrs Engestrom, Bergman, and others, are wrong in the principle; because the wind that passes from the mouth through such long cones loses its velocity by the lateral friction, as happens in hydraulic spouts; which, when formed in this manner, do never throw the fluid so far as when the fluid passes through a hole of the same diameter, made in a thin plate of a little metallic cap that screws at the end of the large pipe. It is on this account that the little cap *c* is employed, having a small hole in the thin plate, which serves as a cover to it; and there are several of these little caps, with holes of smaller and larger sizes, to be changed and applied whenever a flame is required to be more or less strong.

4. Another convenience of these little caps is, that even in case any moisture should escape falling into the hemisphere *bb*, and pass along with the wind through the crooked pipe Q, it never can arrive at nor obstruct the little hole of the cap *c*, there being room enough under the hole in the inside, where this moisture must be stopped till it is cleaned and wiped out.

The stream of air that is impelled by the blow-pipe (as seen in fig. 3.) upon the flame, must be constant and even, and must last as long as the experiment continues to require it. This labour will fatigue the lungs, unless an equable and uninterrupted inspiration can at the same time be continued. To succeed in this operation without inconvenience, some labour and practice are necessary, as already explained under the detached article.

Every assay ought to begin by the exterior flame, which must be first directed upon the mass under examination; and, when its efficacy is well known, then the interior blue flame is to be employed.

Portable Apparatus.

After the ore is roasted, it is to be rounded upon the steel plate by the hammer; the particles being prevented from being dissipated by the ring H (fig. 9. Plate XCIX.), within which the pieces to be broken are to be put.

Among the apparatus, beside the particulars already mentioned, three phials are necessary, containing the required fluxes, viz. the *borax*, the *sal sodæ*, and *sal fusibile microcosmicum*. Other useful particulars are, A small link of hard steel, to try the hardness or softness of mineral substances, and also to strike fire for lighting the candle when required: A piece of black flint, to serve as a touch-stone; (for being rubbed with any metal, if it be gold the marks will not be corroded by aqua fortis); and also to strike fire, when necessary, with the link of steel: An artificial load-stone, properly armed with iron, for the better preservation of its attractive power; (it serves to discover the ferrugineous particles of any ore after it has been roasted and powdered:) A triple magnifier, which, differently combined, produces seven magnifying powers, the better to distinguish the structure and metallic parts of ores, and the minute particles of native gold, whenever they contain that metal: A file, to try the hardness of stones and crystals, &c.: Some pieces of dry agaric or tinder, and small bits or splinters of wood tipped with brimstone, to serve as matches for lighting the candle; and various other little articles of use in these experiments.

II. For performing experiments in the *Humid Way*, the chief additional articles (and which must be kep in a separare case) consist of a collection of phials, containing the principal acids, tests, precipitants, and re-agents, both for examining mineral bodies by the humid way, and for analysing the various kinds of mineral waters. Those with acids and corrosive solutions have not only ground stoples, but also an external cap to each, ground over the stople, and secured downward by a bit of wax between both, in order to confine the corrosive and volatile fluids within. But those which contain mild fluid liquors have not such external caps; and those with dry inoffensive substances are only stopped with cork. Besides these phials, there are two smaller cylindrical ones, which serve to exhibit the changes of colour produced by some of the re-agents in those analytical assays. There are also two or three small matrasses, to hold the substances with their solvents over the fire; a small glass funnel for pouring the fluids; a small porcelain mortar, with its pestle; one or two crucibles of the same substance; a small wooden trough to wash the ground ores; some glass sticks to stir up the fluid mixtures; and, finally, pieces of paper tinged red, yellow, and blue, by the tinctures of Fernambuc wood (commonly called Brasil wood), turmeric, and litmus, thickened with a little starch.

The following list contains the names of the various fluid tests and re-agents that are necessary for these assays. But the whole number being too large to be all contained in a portable case, every one may give the preference to those he likes best.

1. Concentrated vitriolic acid, whose specific gravity may be expressed in the outside.
2. Nitrous acid, purified by the nitrous solution of silver.
3. Concentrated marine acid, with its specific gravity.
4. Marine acid dephlogisticated.
5. Aqua regia for gold, viz. 2 nit. and 1 marine.
6. Aqua regia for platina, viz. half marine and half nitrous acid.
7. Nitrous solution of silver.
8. Nitrous solution of mercury, made in the cold.
9. Muriatic solution of barytes.
10. Nitrous solution of lime.
11. Muriatic solution of lime.
12. Mercury in its metallic state.
13. Corrosive sublimate of mercury.
14. White arsenic.
15. Nitrous solution of silver.
16. Nitrous solution of copper.
17. Acid of sugar.
18. Liquor probatorius vini.
19. Hepar sulphuris.
20. Oil of tartar *per deliquium*.
21. Salt of tartar.
22. Caustic vegetable alkali.
23. Pearl-ashes.
24. Soap-makers ley.
25. Common salt.
26. Vitriolated argilla (alum.)
27. Vitriol of iron (copperas.)
28. Nitrous solution of silver.
29. Acetous solution of lead.
30. Acetous solution of barytes.
31. Phlogisticated alkali by the Prussian blue.
32. Lime-water.
33. Lime-water phlogisticated by the Prussian blue.
34. Caustic volatil alkali.
35. Mild volatile alkali (dry.)
36. Rectified spirit (alcohol.)
37. Æther.
38. Spirituous tincture of galls.

The following tests are very fit also for these assays, viz. 39. Spirituous solutions of soap; 40. Syrup of violets; 41. Tincture of litmus; 42. Tincture of Brasil wood; 43. Tincture of turmeric; 44. Oil of olives; 45. Oil of linseed; 46. Oil of turpentine; 47. Essential salt of wild-sorrel; 48. Hepar sulphuris; 49. Sugar of lead; 50. Solution of alum.

The method of applying the above tests of acids and re-agents may be seen in Bergman's treatises of the Analysis of Waters, and of Assaying by the Humid Way; in Kirwan's Elements of Mineralogy; in the Elements of Chemistry of Dijon; in the Memoirs of the same Academy; in Fourcroy's Lectures of Chemistry, &c.

III. The *Lamp-furnace* Laboratory, for experiments both by the *humid* and the *dry* way, is a very curious and useful, though small apparatus. It is an improvement of that which was contrived by M. de Morveau, in consequence of the information he received from his friend the president de Virly, who saw at Upsal how advantageously the late eminent professor Bergman availed himself of this convenience for many analytical processes in miniature, by the use of very small glass vessels about one inch diameter, and other implements of proportional size, for performing various chemical operations. (See the Dijon Memoirs for 1783, Part 1. p. 171.)

Portable Apparatus.

There can be no doubt but that whenever theſe proceſſes are properly conducted, though in miniature, the lamp-furnace will prove amply ſufficient to perform in a few minutes, and with very little expence, the various ſolutions, digeſtions, and diſtillations, which otherwiſe would require large veſſels, ſtills, retorts, reverberatory furnaces, &c. to aſcertain the component parts of natural bodies; though it is not always ſufficient to aſcertain their reſpective quantities. In this laſt caſe, operations muſt be performed in great laboratories, and on a large ſcale, at a conſiderable expence. But the ſubſtances are ſometimes too valuable; as, for inſtance, when precious ſtones are examined; and of courſe the laſt way never can be attempted in ſuch caſes.

Theſe ſmall proceſſes have likewiſe another advantage before noticed, which cannot be obtained in works at large. It conſiſts in one's being able to obſerve the gradual progreſs of each operation; of eaſily retarding or urging it, as it may require; and of aſcertaining at pleaſure each ſtep of every experiment, together with the phenomena attending the ſame.

The lamp-furnace is mounted in a ſmall parallelogram of mahogany, about ſix inches long and four wide, marked fig. 5. This is kept ſteady over the edge of a common table, by means of the metallic clamp *wv*, which is faſtened by the ſcrew *x*. The pillar *rs* is ſcrewed in a vertical poſition on the plate *s*, being about ten inches high; the other is ſcrewed to the oppoſite corner, marked *pk*, and is only 7¼ inches long; both are compoſed of two halves, that ſcrew at *tt*, to be eaſily packed up with all the implements in a caſe covered with black fiſh-ſkin, and lined with green velvet, like the other laboratory already deſcribed.

Plate CCCXIII.

The lamp *k*, fig. 3. is ſupported on the plate *f*, which has a ring *l* that runs in the column *pk*, and may be fixed by its ſcrew *l* at the required height.—This lamp has three ſmall pipes of different ſizes, to receive as many wicks of different thickneſs, and to be filled with ſpirit of wine. By a ſimilar method, a piece of charcoal is mounted and ſupported by the pliers or little forceps ſcrewed to the arm *ac*, fig. 1. which has all the motions requiſite for being fixed by means of proper ſcrews, at a proper diſtance from the flame of the wick *h*. The blow-pipe, fig. 4. is, by a ſimilar mechaniſm, mounted on the ſmaller column *pq*, at ſuch a diſtance as to blow the flame *hi* to the piece of ore *m*, which is upon the charcoal *gf*.

Every thing being diſpoſed in this manner, the operator blows through the mouth-piece of the blow-pipe, fig. 4. and remains with his hands free to make the changes and alterations he may think proper.—

[*N. B.* The large round cavity *e* in the middle of the parallelogram, fig. 5. is to receive the lamp *k*, fig. 3. when all the implements are packed up in their caſe of black fiſh-ſkin; and the cover of the lamp is repreſented by fig. 12.]

But if the operator has the double bellows, fig. 14. and 15. he fixes them, at a due diſtance, to the ſame table by the braſs clamp *y*. He then unſcrews the blow-pipe at *zz*: joins the mouth *m* of the flexible tube to the hemiſphere *zz*, paſſing each orifice, thro' the leather tube fig. 11. and tying both ends with a waxed thin pack-thread. If he works with his foot on the pedal, the ſtring of which is ſeen hanging from the end of the bellows, fig. 15. (and is always up, on account of the weight *e*), then the air is abſorbed by the bellows fig. 15. from whence it is propelled by the motion of the foot on the pedal to the bellows, fig. 14. whoſe conſtant weight *r* drives it out through the flexible pipe, fig. 10. it of courſe enters the curbed part *zzi* of the blow-pipe, and drives the flame on the piece *m* of the ore, that is to be examined upon the charcoal.

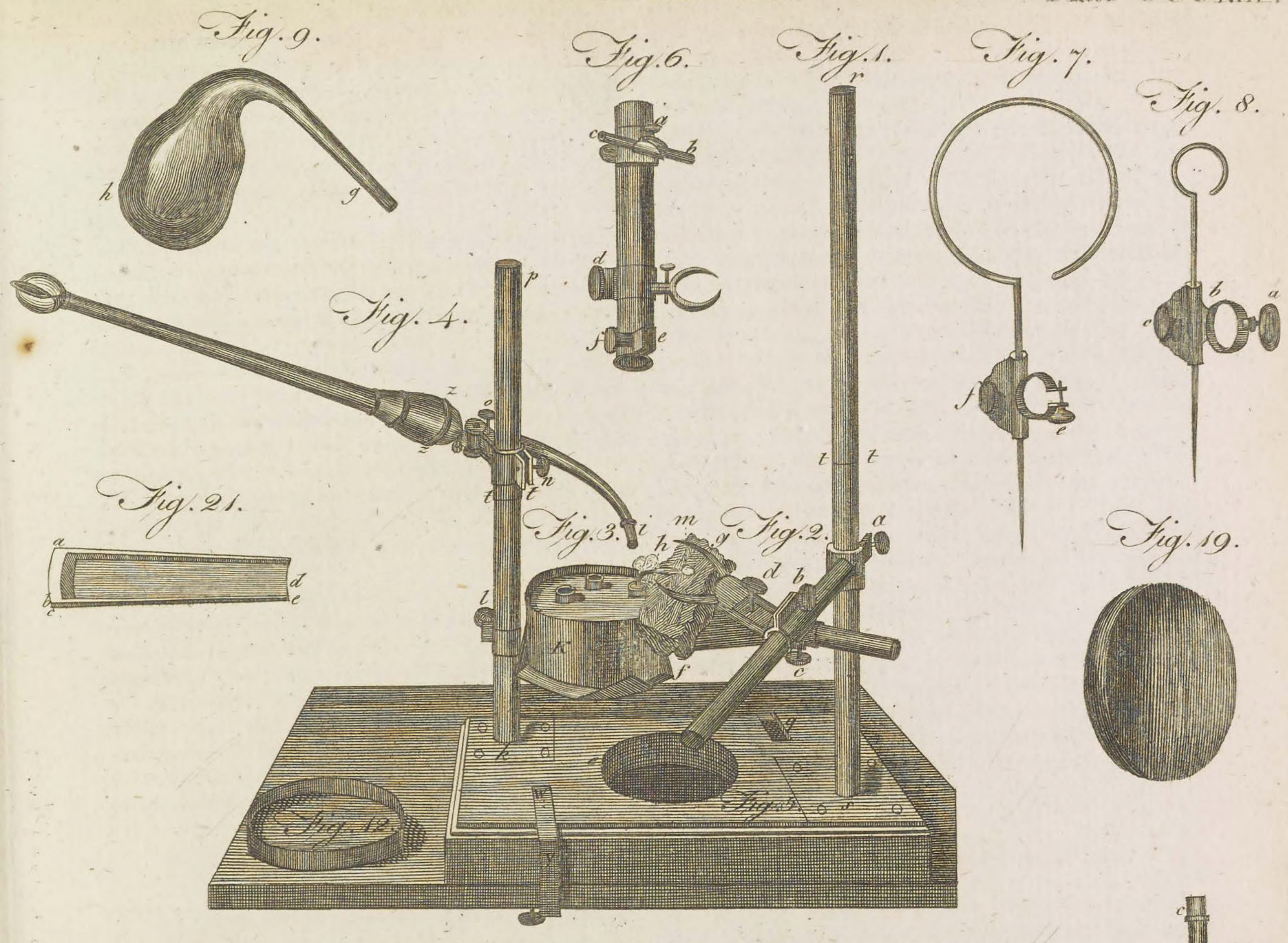
[*N. B.* 1. This double bellows is packed up by itſelf in a mahogany caſe, about 9 inches long, 6½ wide, and about 3½ deep, outſide meaſure. 2. The laſt blowing bellows, fig. 14. has an inſide valve, which opens when the upper ſurface of it is at its greateſt height; in order to let the ſuperfluous air eſcape out, as it would otherwiſe iſſue with great velocity out of the tube, fig. 11. and ſpoil the operation.]

If the operator chooſes to apply the vital or dephlogiſticated air in his proceſs, let him fill the glaſs-jar *h*, fig. 17. with this air; and put it within the tub marked by *abze*, filled with water, faſtening the neck of the jar within by a croſs-board *ed*, which has a hole in it for that purpoſe; then introducing the two ends of the flexible hollow tube, fig. 16. both to the mouth of the jar and to the hole of the bellows fig. 15. he opens the hole *m* of the jar, that was ſtopped with the ſtople *n*; the column of the water paſſes in through *m*, and forces up the vital air, which enters the bellows, and of courſe, by the alternate motion of the pedal, paſſes through the end of the blow-pipe, to urge the flame upon the piece of ore *m*, fig. 2. on the charcoal *g*. But the dephlogiſticated air may be alſo received at the ſame time that it is produced, by tying the pipe, fig. 16. to the mouth of an earthen retort, or even of a glaſs retort well-coated, according to the method of Mr Willis, deſcribed in the Tranſactions of the Society of Arts, Vol. V. p. 96. This laſt conſiſts in diſſolving two ounces of borax in a pint of boiling water, and adding to the ſolution as much ſlacked lime as is neceſſary to form a thin paſte. this glaſs retort is to be covered all over with it, by means of a painter's bruſh, and then ſuffered to dry. It muſt then be covered with a thin paſte made of linſeed oil and ſlacked lime, except the neck that enters into the receiver. In two or three days it will dry of itſelf; and the retort will then bear the greateſt fire without cracking Two ounces of good nitre, being urged in the retort, by a good fire on a chafingdiſh, will afford about 700 or 800 ounce-meaſures of dephlogiſticated air.

To make any other kind of chemical aſſays, the forceps of fig. 2. which ſupports the charcoal, is taken off, by unſcrewing the ſcrew *b*; the blow-pipe is alſo taken off, by looſening the ſcrew *n*; the hoop fig. 7. is put in its place, where the metallic baſin of fig. 19. is put filled with ſand: the piece of fig. 8. is ſet on the other pillar *rs*, fig. 1. to hold the matraſs, fig. 18. upright, or the receiver fig. 20. &c.

In the ſame manner, the retort, fig. 9. may be put in the ſand-bath inſtead of the matraſs, with its receiver fig. 20. which may be ſupported on a bit of cork or wood, hollowed to its figure, and held by the pliers, inſtead of the charcoal fig. 2.

But if the operation is to be made in the naked fire,



A. Bell Prin. Mal. Sculptor fecit.

Of Arrangement.

fire, the neck of the retort, fig. 9. being luted to the receiver, or balloon, fig. 20. may be hanged by a little chain with its ring over the flame, being fufpended from the piece of fig. 7. or 8. fcrewed to either of the pillars as may be moft convenient. Otherwife the receiver, fig. 20. may be fupported by the round hoop of brafs, fig. 8. or 7. fcrewed at a proper height to the pillar, fig. 1. tying round it fome packthread to defend the glafs from the contact with the metallic fupport.

The piece of fig. 6. may be fcrewed by its collar and fcrew *ef* to any of the pillars; carrying with it the retort and its receiver, at proper diftances, higher or nearer to the lamp according as the flame is more or lefs violent.

It eafily may be conceived, that thefe implements afford all forts of conveniences for making any kind of fmall operations and affays in miniature, provided the operator pays a proper attention to the difpofition requifite for each procefs or operation.

Every glafs retort, receiver, matrafs, bafon, fmall funnels, &c. are made by the lamp-workers, that blow beads, thermometers, and other fmall glafs inftruments.

It is directed that the lamp *k*, fig. 3. be filled with fpirit of wine, becaufe it gives no difagreeable fmell, and does not produce any fuliginous and difagreeable cruft on the veffels as oil does: moreover, the fpirit gives a dry flame, without fmoke, and ftronger than oil; befides the fpots and difagreeable confequences this laft caufes, if fplit, &c. M. de Morveau adds, that the expence of fpirit is quite inconfiderable; and that he performed in eight or ten minutes, with this apparatus, various diffolutions, evaporations, and other proceffes, which otherwife would have taken more than three hours, with the expence only of two or three halfpence for the fpirit of wine, whilft the fuel of charcoal would have coft near ten or eleven pence.

But a very important circumftance is, as Morveau obferves likewife, that many philofophers do not apply themfelves to chemical operations, for want of opportunity of having a laboratory to perform them: it requiring a proper room, and fuitable expences of many large furnaces, retorts, crucibles, and numerous other implements, &c. whilft thefe miniature laboratories may in great meafure afford the fame advantages; at leaft to that degree of fatisfaction fufficient to afcertain the contents and products of any fubftance that is fubjected to trial: for with this fimple apparatus a man of fome abilities may, without any embarafsment, in a very fhort time, and with little expence, perform fuch diftillations as require a reverbatory furnace; all forts of proceffes, digeftions, and evaporations, which require a regular fand heat; he may vary his experiments or trials, and multiply them to a great number of various performances, draw up his conclufions, and reafon upon them, without lofs of time, without the hinderance of long preparations to work at large. And even when fuch large works are to be performed, he may obferve beforehand various phenomena of fome fubftances, which being known in time, would otherwife impede the proceffes at large, or make them fail abfolutely; and all this without the rifk of a confiderable lofs, and without expofing himfelf to a great fire, &c.

PART II. ARRANGEMENT (A) of MINERAL BODIES (B).

THE bodies belonging to the mineral kingdom are divided into four different claffes, viz.

1. *Earths* (C), or thofe fubftances which are not ductile, are moftly indiffoluble in water or oil, and preferve their conftitution in a ftrong heat.
2. *Salts*: thefe diffolve in water, and give it a tafte; and when the quantity of water required to keep them in diffolution is evaporated, they concrete again into folid and angular bodies.
3. *Inflammables*, which can be diffolved in oils, but not in water, and are inflammable.
4. *Metals*, the heavieft of all bodies; fome of which are malleable, and fome can be decompounded.

Here, however, it muft be obferved, that thefe claffes are unavoidably blended one with another; and therefore fome exceptions muft be allowed in every one of them: for inftance, in the firft clafs, the calcareous earth is in fome meafure diffoluble in water, and pipe-clay with fome others diminifh fomewhat in their bulk when kept for a long time in a calcining heat. In the third clafs, the calx of arfenic has nearly the fame properties as falts; and there is no poffible definition of falt that can exclude the arfenic, though at the fame time it is impoffible to arrange it elfewhere than among the femimetals. In the fourth clafs it is to be obferved, that the metals and femimetals, perfect or imperfect, have not the fame qualities common to them all; becaufe fome of them may be calcined, or deprived of their phlogifton, in the fame degree of fire in which others are not in the leaft changed, unlefs particular artifices or proceffes are made ufe of: fome of them alfo may be made malleable, while others are by no means to be rendered fo. That the convex furface metals take after being melted, is a quality not particularly belonging to them, becaufe every thing that is perfectly fluid in the fire, and has no attraction to the veffel in which it is kept, or to any added matter, takes the fame figure; as we find borax, *fal fufibile microcofmicum*, and others do, when melted upon a piece of charcoal: therefore, with regard to all that has

(A) According to the fyftem of *Cronftedt* †; altered, augmented, and improved from the Obfervations of other Mineralogifts.

(B) Of the different bodies enumerated in the following claffification, full explanations are given under their refpective names as they occur in the courfe of this Work. See alfo METALLURGY, and CHEMISTRY-*Index*.

(C) By *earths*, the author (Mr Cronftedt) does not mean (ftrictly fpeaking) only earths, but includes under that title all the kinds of ftones or foffils not inflammable, faline, or metallic.

† *Cronftedt's Mineralogy*, 2d edition, in 2 vols, by Magellan.

Earths.

has been said, it is hardly worth while to invent such definitions as shall include several species at once; we ought rather to be content with perfectly knowing them separately.

Class I. EARTHS.

Earths, are those mineral bodies, not ductile, for the most part not dissoluble in water or oils, and which preserve their constitution in a strong heat.

Calcareous Earths.

These bodies are here arranged according to their constituent parts, so far as hitherto discovered; and are divided into five orders. See the article Earth.

Order I. Calcareous Earths (d).

The properties of these are as follow:

1. Friability and falling into a fine white powder after calcination.

2 Partial solution in water, with which they contract

(d) Calcareous earth is most commonly found in the form of lime-stone; hard, compact, and of various colours; under which general name may be comprehended all the different kinds of marbles. Near Bath in England is found a kind of grey stone, rather soft than hard. This contains calcareous earth in a mild state, and likewise some in a state of causticity: hence, when newly dug out of the earth, it will dissolve sulphur, or make lime-water without any calcination. By attraction of fixed air from the atmosphere, it soon hardens after it has been dug up.

Mr Williams * divides the lime-stones of Scotland into the following species:

1. Grey, whitish, and pure white; regularly stratified; of a granulated texture; and much used in the Highlands for building bridges. Some of it is composed of fine glittering spangles like the scales of fishes; and some is as pure white as the best refined sugar, which kind he thinks may be called *Parian marble.*

* *Nat. Hist. of the Mineral Kingdom,* 2 vols.

2. Coarse-looking grey mountain limestone, hard and strong, of a granulated texture, difficult to work in some places rough and unequal, in others smooth and even. Sometimes regularly stratified, at other times appearing like one vast irregular bed or rock, of various thicknesses.

3. Ash-coloured mountain-limestones, consisting of small grains of a fine smooth texture; when broken resembling flint. In the Highlands there are hills of this kind of stone, which our author informs us he has seen; some of which have regular strata, while others appear in one vast mass like a rock of granite.

4. Regularly-stratified lime-stone, found in the low countries, exhibiting a vast variety of colours; as black, blue, grey, brown, purple, red, and ash-coloured, with various mixtures, of all degrees of hardness and purity.

5. Limestone accompanying coal, and frequently the immediate roof of the vein. This likewise shows a great variety of colour, texture, and quality; some being so much adulterated with clay and other heterogeneous mixtures as to be good for nothing, while others are very pure and fine. These limestones are always found in regular strata. "They are found (says our author) as regular as the coals they accompany; and the coal-strata are more regular in continuation upon the bearing, as far as the class of strata belonging to the coal reaches, than any other that I have investigated; and I look upon it, that this observation may be of use in practice."

For discovering limestone at some distance, Mr Williams gives the following directions:—"Let them keep the line of stretch, or bearing of the strata; and, in the coal-country, they will be sure to discover it at nearly the same parallel distance from a seam of coal or other given stratum, as the place where it was last seen. But many of the mountain-limestones are not much to be depended on. Though you may have a good and plentiful quarry in one place, yet, perhaps, half a mile, or half a quarter of a mile farther forward, you cannot discover it: it is dwindled away to nothing, and yet will appear again farther forward; which makes the mountain-limestones uncertain to be discovered where you do not see them; as these rocks very frequently grow thicker or thinner, and sometimes squeezes out to nothing: and I comprehend under this denomination all the limestones not accompanying the coals and coal-metals.—The limestones of the coal-fields are often distinguishable by containing a great variety of shells, coral, and other marine bodies, which are found blended in the heart and composition of the stone."

6. The Scotch marbles are of great variety and beauty; and the parts of the kingdom most unfit for cultivation are found to abound most in them. Assint in Sutherland has a kind of white statuary marble, which Mr Williams says is the purest and best he ever saw. "I am persuaded (says he) there is none better, if any so good, in all Europe, and there is enough of it to serve all Britain; perfectly solid and pure, free of any blemishes, flaws, or stains, and blocks or slabs of any size may be cut out: but there is bad access to it; nor would it be easily quarried, there being a little cover above it, of a soft, loose, whitish limestone. This marble accompanies a prodigious rock of grey limestone, of a granulated texture, appearing in regular strata at Assint; but it is one of those which varies in thickness as you advance along the bearing of the strata. The good white marble of Assint is only to be seen in the bed of the river, near a considerable house a mile or two south of the church; but I cannot remember the name of the particular place."

Near Blairgourie in Perthshire, not far from the side of the high road, is an excellent, granulated, broad-bedded limestone, of a sugar-loaf texture, and as white as the finest statuary marble, which Mr Williams supposes to be a good species of the true Parian marble, and that it requires only to be known and brought into use to become of great value. In the duke of Gordon's lands, in the forest of Glenavon, there is also a kind of marble composed of broad glittering grains like spangles, as large as the scales of fishes; but the situation is remote, and difficult of access.

In

Calcareous Earths.

tract great heat, and by sprinkling with water they fall more readily into powder.

3. Infusibility without addition.

4. They attract the fixed air from the vegetable and mineral alkalies, and thus rendering them much more caustic, becoming at the same time mild themselves.

5. Solubility in all acids except the vitriolic, tartarous, and some anomalous vegetable acids.

6. Fusibility with borax and microcosmic salts.—The fusion is attended with effervescence, and the result is a transparent and colourless glass.

7. With metalline calces they melt into a corrosive slag.

8. They imperfectly reduce the calces of lead and bismuth, and have even some effect upon those of copper and iron.

The calcareous earth is found,

I. Pure.

1. In form of powder. *Agaricus mineralis*, or *lac lunæ*.
 a. White, in moors, and at the bottom of lakes.
 b. Red.
 c. Yellow.

2. Friable and compact. Chalk, *creta*.
 a. White, *creta alba*. Chalk is a nam aelso applied to other earths; whence we hear of chalks of various colours: but there are none which are known to be of a calcareous nature, except this kind here described, and of which there are no other varieties, otherwise than in regard to the looseness of the texture, or the fineness of the particles.

3. Indurated, or hard; Limestone; *Lapis calcareous*.
 A. Solid, or not granulated.
 a. White.
 b. Whitish yellow.
 c. Flesh-coloured, found in loose masses.
 d. Reddish brown.
 e. Grey.
 f. Variegated with many colours, and particularly called *marble*.
 g. Black.
 B. Grained or granulated limestone.
 1. Coarse-grained, and of a loose texture, called *salt-slag* in Swedish, from its resemblance to lumps of salt.
 a Reddish yellow. *b*. White.
 2. Fine-grained.
 a. White. *b*. Semi-transparent, from Solfatara in Italy, in which native brimstone is found.
 3. Very fine grained.
 a. White and green. *b*. White and black.
 C. Scaly limestone.
 1. With coarse or large scales.
 a. White. *b*. Reddish yellow.
 2. With small scales.
 a. White.
 3. Fine glittering or sparkling.
 a. White. *b*. Of many colours.
 D. Lime or calcareous spars.
 (1.) Of a rhomboidal figure.
 A. Transparent or diaphanous.
 1. Refracting spar; *Spatum islandicum*; Iceland spar, or Iceland crystal.—This represents the objects seen through it double,
 2. Common spar, which shows the object single.
 a. White, or colourless.
 b. Yellowish and phosphorescent.
 B. Opaque.
 1. White. 2. Black. 3. Brownish yellow.
 (2.) Foliated or plated spar.
 a. Opaque white.
 E. Crystallized calcareous spars. *Spar. Drusen* (E.)
 (1.) Transparent.
 a. Hexagonal truncated.
 b. Pyramidal.
 1. Dog's teeth; *Pyramidales distinctæ*.
 2. Balls of crystallized spar, *Pyramidales concretæ*.
 F. Stalactitical spar; *Stalactites calcareus*. Stalactites, Stone-icicle, or Drop-stone.
 (1.) Scaled stalactites of very fine particles.
 a. Of a globular form.
 1. White, the pea-stone.
 2. Grey, *pisolithus*, *oolithus*. Also the hammites, from its resemblance to the roes or spawn of fish. It has been exhibited by authors as petrified roes. The Ketton free-stone, of Rutlandshire, is a remarkable stone of this sort.
 b. Hollow, in the form of a cone.
 1. White.
 c. Of an indeterminate figure.
 d. Of coherent hollow cones.
 (2.) Solid stalactites of a sparry texture.
 a. Hollow, and in form of a cone.
 1. White, and semitransparent.

II. Sa-

In Lochaber, near the farm-houses on the north side of the ferry of Ballachylish, is a limestone or marble rock, of a beautiful ashen-grey colour, and a fine regular uniform grain or texture; capable of being raised in blocks or slabs of any size, and of receiving a fine polish. It is beautifully sprinkled with fine bright grains of mundick or pyrites, and likewise with grains or specks of beautiful lead ore of a fine texture.

About three miles south of Fort-William, in the bed of a river, is a curious kind of marble with a black ground, flowered with white, like fine needle-work, or rather resembling the frost flowering upon glass windows in winter; and this flowering is not only on the outside, but quite through all parts of the body of the stone.

Scotland has also chalk in abundace; some of which is regularly stratified, and much appears in thick irregular masses like sediment.

(E) The translator of Mr Cronstedt's Treatise has adopted this German term *drusen* into the English language, for a cluster of regular figured bodies, as a groupe conveys the idea of a cluster only, whether regular or of indeterminate figures.

Calcareous Earths.

II. Saturated or combined with the acid of vitriol. Gypſum, Plaſter-ſtone, or Parget.

1. Looſer and more friable than a pure calcareou earth.
2. Either crude or burnt, it does not excite any effervefcence with acids; or, at moſt, it effervefces but in a very ſlight degree, and then only in proportion as it wants ſome of the vitriolic acid to complete the ſaturation.
3. It readily falls into a powder in the fire.
4. If burnt, without being red-hot, its powder readily concretes with water into a maſs, which ſoon hardens; and then,
5. No heat is perceived in the operation.
6. It is nearly as difficult to be melted by itſelf as the limeſtone, and ſhows moſtly the ſame effects with other bodies as the lime-ſtone: the acid of vitriol ſeems, however, to promote its vitrification.
7. When melted in the fire with borax, it puffs and bubbles very much, and for a long while, during the fuſion, owing to the nature of both the ſalts.
8. When a ſmall quantity of any gypſum is melted together with borax, the glaſs becomes colourleſs and tranſparent; but ſome ſorts of alabaſter and ſparry gypſa, when melted in ſome quantity with borax, yield a fine tranſparent yellow coloured glaſs, reſembling that of the beſt topazes. This phenomenon might probably happen with every one of the gypſeous kind. But it is to be obſerved, that if too much of ſuch gypſum is uſed in proportion to the borax, the glaſs becomes opaque, juſt as it happens with the pure limeſtone.
9. Burnt with any inflammable matter, it emits a ſulphureous ſmell; and may as well by that means, as by both the alkaline ſalts, be decompounded; but for this purpoſe there ought to be five or ſix times as much weight of ſalt as of gypſum.
10. Being thus decompounded, the calx or earth which is left ſhows commonly ſome marks of iron.

The gypſeous earth is found,

(1.) Looſe and friable. Gypſeous earth, properly ſo called; *Guhr*.
 A. White.

(2.) Indurated.
 A. Solid, or of no viſible particles, Alabaſter.
  a. White, alabaſter.
   1. Clear and tranſparent.
   2. Opaque.
  b. Yellow.
   1. Tranſparent, from the Eaſtern countries.
   2. Opaque.
 B. Gypſum of a ſcaled or granulated ſtructure. This is the common plaſter-ſtone.
  1. With coarſe ſcales. *a*. White.
  2. With ſmall ſcales. *a*. Yellowiſh. *b*. Greyiſh.
 C. Fibrous gypſum, or plaſter-ſtone, improperly (though commonly) called *Engliſh talc* by our druggiſts.
  1. With the fibres coarſe. *a*. White, from Livonia.

  2. With fine fibres. *a*. White.
 D. Spar-like gypſum. Selenites, by ſome alſo called *glacies mariæ*; and confounded with the clear and tranſparent mica.
  1. Pure ſelenites.
   A. Tranſparent.
    a. Colourleſs. *b*. Yellowiſh.
  2. Liverſtone, ſo called by the Swedes and Germans.
 E. Cryſtalliſed gypſum. Gypſeous druſen.
  (1.) Druſen of cryſtals of pure ſparry gypſum.
   A. Wedge-formed, compoſed of a pure ſpar-like gypſum.
    a. Clear and colourleſs. *b*. Whitiſh yellow.
   B. Capillary.
    a. Opaque, whitiſh yellow. *b*. Hexagonal, priſmatic. *c*. Globular, conſiſting of cuneated rays proceeding from the centre.
 F. Stalactitical gypſum. *Gipſum ſinter*.
  1. Of no viſible particles; in French, *grignard*.
   A. Of an irregular figure.
    a. Yellow. *b*. White.
  2. Of a ſpar-like texture.
   A. In form of a cone.
    a. White and yellow.
   B. Of an irregular figure.
    a. White.

III. Calcareous earth ſaturated with the acid of common ſalt. *Sal ammoniacum fixum naturale*.
 This is found, 1. In ſea-water. 2. In ſalt-pits.

IV. Calcareous earth combined or ſaturated with ſparry acid, known by the name of *ſparry fluor* and *blue john*.

Theſe are commonly called *fluxing*, *vitreſcent*, or *glaſs*-ſpars; becauſe moſt part of them have a ſparry form and appearance: they are, however, often met in an indeterminate figure.

They are only known in an indurated ſtate, and diſtinguiſh themſelves from the other earths by the following characters.

1. They are ſcarce harder than common calcareous ſpars, and conſequently do not ſtrike fire with ſteel.
2. They do not ferment with acids neither before nor after calcination.
3. They do not melt by themſelves; but crack and ſplit to pieces when expoſed to a ſtrong fire. But,
4. In mixtures with all other earths they are (generally) very fuſible, and eſpecially with calcareous earth, with which they melt into a corroding glaſs that diſſolves the ſtrongeſt crucibles, unleſs ſome quartz or apyrous clay be added thereto.
5. When heated ſlowly, and by degrees, they give a phoſphoreſcent light: but as ſoon as they are made red-hot, they looſe this quality. The coloured ones, eſpecially the green, give the ſtrongeſt light, but none of them any longer than whilſt they are well warm.
6. They melt and diſſolve very eaſily by the addition of borax; and, next to that, by the microcoſmic ſalt, without ebullition.

A. Indurated fluor.

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(1.) Solid, of an indeterminate figure; of a dulll texture, femitranfparent, and full of cracks in the rock.

a. White.

(2.) Sparry fluor. This has nearly the figure of fpar; though on clofe obfervation it is found not to be fo regular, nothing but the gloffy furfaces of this ftone giving it the refemblance of fpar.

a. White. b. Blue. c. Violet. d. Deep green. e. Pale green. f. Yellow.

(3.) Cryftallifed fluor.

1. Of an irregular figure. a. White. b. Blue. c. Red.
2. Of a cubical figure. a. Yellow. b. Violet.
3. Of a polygonal fpherical figure. a. White. b. Blue.
4. Of an octoedral figure. a. Clear, colourlefs.

V. Calcareous earth faturated with a particular acid, perhaps of the metallic kind, *viz.* the tungftenic acid. The *tungftein* of the Swedes.

This refembles the garnet-ftone and the tin-grains; is nearly as heavy as pure tin; very refractory in the are, and exceffively difficult to reduce to metal. Iron has, however, been melted out of it to more than 30 *per cent.* It is very difficultly diffolved by borax and alkaline falts, but melts very eafily with the microcofmic falt, giving a black flag; and for this reafon the laft mentioned falt muft be employed in the affays of this ftone. It is found,

1. Solid and fine-grained.
   a. Reddifh or flefh-coloured. b. Yellow.
2. Spathofe, and with an unctuous furface.
   a. White. b. Pearl-coloured.

VI. Calcareous earth united with the inflammable fubftance.

Thefe have a very offenfive fmell, at leaft when rubbed. They receive their colour from the phlogifton, being dark or black in proportion as it predominates.

(1.) Calcareous earth mixed with phlogifton alone; *Lapis fuillus*, fetid ftone and fpar, or fwine-ftone and fpar.

A. Solid, or of no vifible or diftinct particles.
a. Black.

B. Grained.
a. Blackifh brown.

C. Scaly, *particulis micaceis.*
1. With coarfe fcales, a. Black.
2. With fine fparkling fcales. a. Brown.

D. Sparry.
a. Black. b. Light brown. c. Whitifh yellow.

E. Cryftallifed.
1. In a globular form.

VII. Calcareous earths blended with an argillaceous earth. Marle, *Marga.*

1. When crude, it makes an effervefcence with acids: but,
2. Not after having been burnt; by which operation it is obferved to harden, in proportion as the clay exceeds the calcareous fubftance.
3. It eafily melts by itfelf into a glafs, and even when it is mixed with the moft refractory clay.
4. It is of great ufe in promoting the growth of vegetables, fince the clay tempers the drying quality of the calcareous earth.
5. When burnt in a calcining heat, it readily attracts water: and, expofed to the air, in time it falls into a powder.

Calcareous Earths.

The varieties of this kind worthy to be taken notice of, depend on the different quantities of each of their component parts, and on the quality of the clay. The following are fpecified as examples.

A. Loofe and compact, *Marga friabilis.*
a. Reddifh brown.
b. Pale red. This, when burnt, is of a yellowifh colour, and ufed for making earthen ware in fome places.

B. Semi-indurated; which is nearly as hard as ftone when firft dug up, but moulders in the open air.
a. Grey. b. Red.

C. Indurated or ftone marle.
A. in loofe pieces, *Marga indurata amorpha;* by the Germans called *duckftein* or *tophftein.*
a. White. b. Grey, formed from a fediment which the water carries along with it.
B. In continued ftrata. Hard flaty marle.

VIII. Calcareous earth united with a metallic calx.

Here, as well as in the others, fuch a mixture or combination is to be underftood, as cannot be difcovered by the eye alone without the help of fome other means.

The fubjects belonging to this divifion lofe the property of raifing an effervefcence with acids, when they are rich in metal, or contain any vitriolic acid. However, there have been found fome that contained 20 or 30 *per cent.* of metal, and yet have fhown their calcareous nature by the nitrous acid.

There are no more than three metals hitherto known to be united in this manner with the calcareous earth, *viz.*

(1.) With iron. White fpar like iron ore, *Minera ferri alba.* The *ftahlftein* or *weifes eifenerz* of the Germans.

1. This ore, however, is not always white, but commonly gives a white powder when rubbed.
2. It becomes black in the open air, as likewife in a calcining heat.
3. In this laft circumftance it lofes 30 or 40 *per cent.* of its weight, which by diftillation has been found owing to the water that evaporates; and it is poffible that fome fmall quantity of vitriolic acid may, at the fame time, evaporate with the water.
4. It is of all the iron ores the moft eafy to melt, and is very corrofive when melted.

This kind is found,

A. Loofe; the mouldered part of the indurated fort.
a. Black, like foot.
b. Dark brown, fomewhat refembling umbre.

B. Indurated.
1. Solid, of no diftinct particles.
   a. Red, Looks like red ochre, or the red hæmatites, but diffolves in the acid of nitre with a great effervefcence.
2. Scaly, *particulis micaceis.*
   a. White.
   b. Blackifh grey.
3. Spar-like.
   a. Light brown.

Calcareous Earths.

4. Drusen.
   a. Blackish brown.
   b. White.
      1. Porous. This is often called *eisen-blute*, or *flos ferri*.
      2. Cellular.

(2.) With copper.
   A. Loose and friable. Mountain blue; Germanice, *Bergblau*. This dissolves in aquafortis with effervescence.
   B. Indurated.
      1. Pure calcareous earth mixed with calx of copper. Armenian stone, *lapis Armenus*.
      2. Gypseous earth united with calx of copper. Is of a green colour; and might perhaps be called *turquoise ore*, or *malachites*; though we do not know if all sorts of turquoise ore are of this nature.
         a. Semi-transparent, is found at Ardal in Norway.

(3.) With the calx of lead.
This is a lead ochre, or a spar-like lead-ore, which, in its formation, has been mixed with a calcareous earth, and for that reason effervesces with acids.
   A. Loose and friable.
      1. White.
   B. Indurated.
      1. Scaly.
         a. Yellowish.
         Both these varieties contain a considerable quantity of lead, *viz.* 40 *per cent.* more or less; and the calcareous earth is as equally and intimately mixed with it, as in the white iron ore.

IX. The following compounds of calcareous earth with different mineral substances are added from Mr Kirwan's Elements of Mineralogy.

1. A compound of calcareous and barotical earths: of this species are some yellowish stones found in Derbyshire, consisting of lumps of limestone interspersed with nodules of baroselenite. Many more may occur as compounds of gypsum and baroselenite, fluor and baroselenite, &c. &c.
2. Compounds of calcareous and magnesian earths; such as,
   a. The white marble interspersed with spots of steatites or soap-rock, either green or black, called by Cronstedt *kolmord marble*. This marble is of a scaly texture.
   b. The *pietra talchina* of the Italians, which consists of white spar with veins of talc.
   c. The *verde antico* of the Italians, which is a light green marble, with deep green, black, white, and purple spots. According to Mr Bayen, it contains 62 parts of mild calcareous earth, 30 of green talc, 1 of magnesia, and 1 of semiphlogisticated iron.
3. Compounds of calcareous and argillaceous earths; such as,
   a. The green Campan marble from the Pyrenées. It is slaty and somewhat magnetic. According to Mr Bayen, it contains 65 of mild calcareous earth, 32 of the argillaceous, and 3 of semiphlogisticated iron.
   b. The red Campan marble: this is not magnetic; it contains 82 parts of mild calcareous earth, 11 of argillaceous shistus, and 7 of dephlogisticated iron.
   c. Yellow figured marble from Florence: according to Mr Bayen, it contains 75 parts of mild calcareous earth, 13 or 14 of shistus, and 4 or 5 of dephlogisticated iron.
   d. Griotte marble from Autun of Burgundy in France: it contains 67 parts of mild calcareous earth, 26 of reddish schistus, 2 of iron, and 1 of magnesian earth.
   e. The Amandola, which is a green marble, honey-comb like, with white spots. It contains 76 parts of mild calcareous earth, 20 of schistus, and 2 of semiphlogisticated iron. The cellular appearance proceeds from the schistus.
4. Compounds of calcareous earth and mica; such as,
   a. The cipolin from Autun in France: it is of a green colour, and consists of 83 parts of chalk, 12 of green mica, and 1 of iron.
   b. The micaceous limestone, is of a glittering appearance, of various degrees of hardness, and effervesces with acids. Such as the macigno of the Italians; their yellow pietra bigia; and their blue pietra columbina or turkina.
5. Compounds of calcareous and siliceous earths; such as,
   a. The calcareous quartz and pudding-stone: this consists of lumps of quartz, and sometimes of felt-spar in a calcareous cement.
   b. The limestone with veins of quarts; such as the *saxum sahlbergense*, and several marbles of Sweden and Siberia, which strike fire with steel.
6. Calcareous volcanic pudding-stone; such as,
   a. The cierchina, which consists of lumps of spar and lava in a calcareous cement, mentioned by Mr Ferber.
   b. The marble mixed with veins of black or green lava, mentioned by the same anthor.
7. Compounds of calcareous earth, mixed with two or more kinds of earth; such as,
   a. The cipolin from Rome, which is a green marble with white zones: it strikes, though difficultly, fire with steel: it contains 67,8 parts of mild chalk, 25 of quartz, 8 of shistus, and 0,2 of iron, besides the iron contained in the argillaceous shistus.
   b. The calcareous porphyry, which consists of quartz, felt-spar, and mica in separate grains united by a calcareous cement.
   c. The limestone interspersed with shoerl and mica.
   d. To these compounds belongs the pyritaceous limestone called by the French *Pierre de St Ambroix*. It is of an iron grey colour, interspersed with shining particles. Its texture is compact, and scarcely gives fire with steel. Its specific gravity is 2,7034. It is soluble in acids, and mostly with effervescence; calcines in a strong fire; makes nitre slightly detonate; and if distilled affords a small portion of vitriolic acid, and some sulphur sublimes. Its component

Ponderous Earth.

ponent parts are 75 of mild calcareous earth and 25 of pyrites; in which are contained 14 of argill, 7 of quartz and sulphur, and 4 of iron.

Order II. Ponderous Earth.

Ponderous earth, (*Terra Ponderosa*): Cauk, or calk. See Earth, Art. I. This is a particular kind of earth (like chalk in appearance, but with some very different properties), discovered in Sweden about 1774, which by its results with other bodies has some similarity to the known alkalis. It has not yet been found pure, but mixed with other substances: however, its great specific weight easily distinguishes it from the others, it being the heaviest of all earths.

1. Its specific gravity when considerably purified by art is 3,773.
2. This earth combines with aerial acid: and in this case effervesces with stronger acids.
3. With vitriolic acid it forms the ponderous spar, which is insoluble in water.
4. Its crystallization, after being combined with the nitrous, or with the muriatic acids, is hardly soluble;
5. But with acetous acid, it becomes deliquescent.
6. When pure; viz. without any mixture of acid or alkali, it does not vitrify in the fire.
7. If deprived of the aerial acid (fixed air) by calcination, is then soluble in 900 times its weight of boiling water. This solution exposed to air, forms a cremor, like that of lime-water in the same circumstances, and like it changes also the vegetable colours.
8. Whilst combined with aerial acid, it is only soluble in about 1550 times its weight of water, chiefly if the water has been impregnated also with the same aerial acid.
9. It expels the caustic volatile alkali from ammoniacal salt.
10. Mixed with brimstone it produces a hepar sulphuris, whose solution in water is but incompletely decomposed either by the nitrous or the muriatic acid, on account of the great attraction between this earth and the acid of sulphur, which is so strong that it
11. Separates this acid (the vitriolic) from the vegetable alkali.

I. Combined with aerial acid; *Terra ponderosa aërata.* See Chemistry-*Index.*

It resembles alum, but is hard and striated, as if composed of radiating fibres coming from a centre. It is found in Alston-moor in England.

A. Spar-like gypsum.

1. Semitransparent, *spatum Bononiense.* The Bononian stone, or native phosphorus.
2. Opaque. *a.* White. *b.* Reddish.

B. Ponderous Drusen spar.

1. Jagged, *cristatum.* These resemble cock's combs, and are found in clefts and fissures accreted on the surfaces of balls of the same substance.
2. White.
3. Reddish.

II. United with phlogiston and the vitriolic acid. *Leberstein* of the Germans and Swedes. *Lapis hepaticus.*

Magnesian Earths.

This stone in some specimens constantly, but in others only when rubbed, smells like the *hepar sulphuris*, or gun-powder.

It is found.

A. Scaly.

1. With coarse scales. *a.* Whitish yellow.
2. With fine sparkling scales. *a.* Black.

Order III. Magnesian, Micaceous, and Asbestine Earths.

§ 1. *Magnesian Earths.*

Magnesia is a white, loose, and light earth, only known since the beginning of this century. It is generally found combined or mixed with other heterogeneous substances, as other simple earths are.

1. When pure its specific gravity is 2,330, and then
2. It neither hardens, contracts, nor melts by the application of heat, even by the solar rays.
3. But it melts easily with borax, or microcosmic salt; though it is scarcely affected by fixed alkalis or calces of lead.
4. Mixed with other earths, it produces by fire different hard masses.
5. It gives no causticity except to the volatile alkali: and
6. Does not effervesce with any acid.
7. When mixed with water it shows a very small degree of heat, but without any effervescence. And when the water exceeds the weight of magnesia about 7,692 times, it is totally dissolved.

8 and 9. Being put in water and afterwards dried, it contains $\frac{18}{100}$ parts of its weight; though when saturated with aerial acid, it will absorb and retain after being dried $\frac{66}{100}$ parts of water.

10. This earth combined with aerial acid is more soluble in cold than in hot water.
11. Combined with vitriolic acid it crystallizes into a bitter salt, known by the name of *Epsom* and *Seydlitz* or *Seidschulitz* salt, which is soluble in little more than its own weight of water.
12. With nitrous acid it forms a deliquescent salt.
13. With the muriatic or the acetous acids it does not crystallize: and the mass being dried, attracts humidity from the air.
14. It has a stronger attraction to the fluor acid than to any other (Berg.): and crystallizes with it into hexangular prisms whose ends are formed of two low pyramids, of three rhombs (*Romé de l'Isle*).
15. It is not precipitated from other acids by the vitriolic, as calcareous earth is.
16. According to Lavoisier and Macquer, when magnesia is calcined, it becomes phosphorescent.

I. Magnesia combined with vitriolic and other acids.

A. When saturated with the vitriolic acid, it forms a bitter salt, called *English* or *Epsom*, *Seydshutz* or *Sedlitz* salt. The salts known under these dif-

Magnefian Earths.

ferent names only differ from one another on account of fome heterogeneous fubftance, which is combined in them, the vitriolated magnefia being the characteriftic and principal ingredient in them all.

B. Magnefia is found not only combined with the vitriolic acid in the waters of Epfom, Sedlitz, &c. but alfo with the marine acid to a confiderable quantity in fea-water and other falt fprings.

C. It is contained frequently in frefh waters, where it is diffolved by means of a quantity of aerial acid.

II. Combined with other earths.

A. Magnefia, when combined with filiceous earth, is commonly unctuous to the touch, and more or lefs difficult to be cut or turned in proportion to its different degrees of hardnefs.

It is not diffufible in water: grows hard, and is very refractory in the fire.

When pounded and mixed with water, it will not eafily cohere into a pafte: however, if it is managed with care, it may be baked in the fire to a mafs, which being broken, fhows a dull and porous texture.

It takes for the moft part, and without much labour, a fine polifh. It is found,

(1.) Compact and foft; *Smectis*, *Briançon* or French chalk.

a. White, from the Lands-End, in Cornwall.

b. Yellow.

c. Red and white, from the Lands-End: the foap-earth, from Switzerland: it looks like Caftile-foap.

(2.) Solid and compact; of impalpable particles: Steatites or foap-rock.

a. White, or light green. *b.* Deep green — *c.* Yellow.

(3.) Solid, and of vifible particles; ferpentine ftone.

A. Of fibrous and coherent particles.

This is compofed, as it were, of fibres, and might therefore be confounded with the afbeftus, if its fibres did not cohere fo clofely with one another, as not to be feen when the ftone is cut and polifhed. The fibres themfelves are large, and feem as if they were twifted.

a. Deep green. It is fold for the *lapis nephriticus*, and is dug at fome unknown place in Germany. *b.* Light green, from Skienfhyttan, in Weftmanland; is ufed by the plate-fmiths inftead of French chalk.

B. Of granulated particles; fine grained fepentine ftone, the Zoeblitz ferpentine.

a. Black. *b.* Deep green. *c.* Light green. *d.* Red. *e.* Bluifh grey. *f.* White. Thefe colours are all mixed together in the ferpentine ftone from Zoeblitz, but the green is the moft predominant colour.

B. Porcelain earth mixed with iron; *terra porcellanea* This is,

A. Diffufible in water.

a. Red, from Montmartre, and China. The water-clinkers which are imported from certain places in Germany feem to be made of this kind.

B. Indurated.

1. Martial foap earth.

a. Red.

2. Martial foap rock.

a Black.

b. Red.

C. The telgften of the Swedes; *lapis ollaris*.

a. Light grey. *b.* Whitifh yellow. *c.* Dark grey. *d.* Dark green.

The ferpentine ftone has many varieties; being found, (1.) Veined or fpotted with green fteatites. (2.) Red, with veins of afbeftos. (3.) Red, green, yellow, or black with veins or fpots of white calcareous fpar, is called *potzevera*. The black is called *nero di prato*; the green *verde di Suza*; but thefe names are not reftrained to this fpecies. (4.) Veined or fpotted with gypfum. (5.) Veined or fpotted with barofelenite. (6.) Veined or fpotted with fhiftus — And, (7.) With veins of quartz, feltfpar, or fhoerl. (*Kirwan's Mineralogy*.)

What is commonly called *ferpentine* is a true *lapis ollaris*; but being variegated with green, yellowifh, and brown fpots, like the fkin of fome common ferpents, it is called by that name. Great quantities of this ftone are found in Italy and Switzerland, where it is often worked into the fhape of difhes and other vafes. (*Fabroni*.) And the *gabro* of the Italians is nothing elfe but a kind of ferpentine, (*Kirwan*.)

§ 2. *Micaceous Earths*.

Thefe are known by the following characters:

1. Their texture and compofition confift of thin flexible particles, divifible into plates or leaves, having a fhining furface.
2. Thefe leaves or fcales expofed to the fire lofe their flexibility and become brittle, and then feparate into inner leaves: but in a quick and ftrong fire, they curl or crumple, which is a ftep towards fufion; though it is very difficult to reduce them into pure glafs by themfelves or without addition.
3. They melt pretty eafily with borax, the microcofmic falt, and the alkaline falt: and may by means of the blow-pipe be brought to a clear glafs with the two former falts. The martial mica is, however, more fufible than the uncoloured ones: its fpecific gravity is 3,000.

A. Colourlefs or pure mica; daze, glimmer, or glift.

1. Of large parallel plates; Mufcovy glafs. This is tranfparent as glafs; found in Siberia and Elfdalen in the province of Wermeland.
2. Of fmall plates, from Silfverberget, at Runneby, in the province of Blekinge.
3. Of fine particles like chaff; chaffy mica.
4. Of twifted plates; crumpled mica.

B. Coloured and martial glimmer.

1. Brown, femi-tranfparent.
2. Of fine and minute fcales.

a. Brown. *b.* Deep green. *c.* Light green. *d.* Black.

3. Twifted or crumpled glimmer.

a. Light green.

4. Chaffy glimmer.

a. Black.

4 5. Chry-

Magnesian Earths.

5. Chryftallized glimmer.
   a. Of concentrated and erect fcales.
   b. Of hexagonal horizontal plates.

The tranfparent Mufcovy glafs is ufed for windows, and upon all occafions where panes of glafs are wanted. Perhaps it might alfo be advantageoufly employed to cover houfes.

The twifted or crumpled mica, which is found at Hardol in Jemtland, is there manufactured into kettles and other veffels, as alfo for hearths of chimnies: and the powder which falls in the working may be mixed with the common falt for the diftillation of the muriatic acid.

§ 3. *Afbeftine Earths.*

Thefe are only yet difcovered in an indurated ftate; and their characters are as follows:

1. When pure, they are very refractory in the fire.
2. In large pieces they are flexible.
3. They have dull or uneven furfaces.
4. In the fire they become more brittle.
5. They do not ftrike fire with the fteel.
6. They are not attacked by acids.
7. They are eafily brought into fufion by borax or alkali.

In this fection are included both thofe varieties which by foffilogifts have been mentioned under the names of *amiantus* and *afbeftus*, and have often been confounded together.

I. Afbeftus, which is compounded of foft and thin membranes; *amiantus Wallerii.*
   A. Of parallel membranes: *Corium, five caro montana,* Mountain-leather.
      1. Pure. a. White.
      2. Martial. a. Yellowifh brown.
   B. Of twifted foft membranes; mountain-cork.
      1. Pure. a. White.
      2. Martial. a. Yellowifh brown.

II. Of fine and flexible fibres; or earth flax: *afbeftus Wallerii.*
   A. With parallel fibres: *Byffus.*
      1. Pure and foft. a. Light green. b. White.
      2. A little martial, and more brittle.
         a. Greenifh, from Baftnas Grufva, at Ryddarhyttan in Weftmanland. There it forms the greateft part of the vein out of which the copper ore is dug; a great part of it is confequently melted together with the ore, and is then brought to a pure femi-tranfparent martial flag or glafs.
   B. Of broken and recombined fibres.
      1. Martial. a. Light green.

Order IV. Siliceous Earths.

Siliceous earth is, of all others, the moft difficult to defcribe and to diftinguifh perfectly; however, it may be known by the following characters, which are common to all bodies belonging to this order.

1. In its indurated ftate it is hard, if not in regard to the whole, yet at leaft in regard to each particle of it, in a degree fufficient to ftrike fire with fteel, and to fcratch it, when rubbed againft it, though the fteel be ever fo well tempered.
2. When pure, and free from heterogeneous particles, it does not melt by itfelf, neither in a reverbatory nor in a blaft furnace.

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3. After being burnt, it does not fall to a powder, neither in the open air nor in water, as the calcareous earth does, but becomes only a little loofer and more cracked by the fire, unlefs it has been very flowly, and by degrees, heated.
4. It excites no effervefcence with acids.
5. In the fire it melts eafieft of all to a glafs with the fixed alkaline falt; and hence it has got the name of vitrefcent, though this name is, properly fpeaking, lefs applicable to this order than to a great many other earths.

To the above we may add the following properties, from Bergman.

6. It is not foluble in any of the known acids, the fluor-acid only excepted. But,
7. It may be diffolved by the fixed alkali, both in the dry and wet way.
8. If the fixed alkali is only half the weight of the filiceous earth, it produces a diaphonous and hard glafs: but when it is in a double or triple proportion, then the glafs deliquefces of itfelf by attracting the humidity of the atmofphere.
9. It melts eafily with borax; but
10. With microfcomic falt it is more difficult, and requires a longer time to melt.
11. This earth has a great analogy to acids, as it is perfectly diffolved in that wonderful natural hot-water-fpout above ninety feet high at Geyfer, in Iceland, where by cooling it forms a filiceous mafs.

§ 1. *Gems, or precious ftones.*

I. Diamond. *Adamas gemma.* See Diamond.
   1. Of all ftones, it is the hardeft.
   2. Is commonly clear, or tranfparent; which quality, however, may, perhaps, only belong to its cryftals, but not to the rock itfelf from which they have their origin.
   3. Its fpecific gravity is neareft 3,500. When brought to Europe in its rough ftate, it is in the form either of round pebbles with fhining furfaces, or of cryftals of an octoedral form.
   a. Colourlefs, or diaphonous, or the *diamond* properly fo called.
      But it alfo retains this name when it is tinged fomewhat red or yellow. Being rubbed, it difcovers fome electrical qualities, and attracts the maftic.
   b. Red; Ruby. *Adamas ruber; Rubinus.*— Which, by lapidaries and jewellers, is, in regard to the colour, divided into,
      1. The ruby of a deep red colour inclining a little to purple.
      2. Spinell, of a dark colour.
      3. The balafs, pale red, inclining to violet. This is fuppofed to be the mother of the rubies.
      4. The rubicell, reddifh yellow.
      However, all others do not agree in the characters of thefe ftones.

II. Sapphire. *Sapphyrus gemma.*
   It is tranfparent, of a blue colour; and is faid to be in hardnefs next to the ruby, or diamond.

III. To-

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III. Topaz. *Topazius gemma.*

a. The pale yellow topaz; which is nearly uncoloured.

b. The yellow topaz.

c. Deep yellow, or gold coloured topaz, or oriental topaz.

d. Orange-coloured topaz.

e. The yellowiſh green topaz, or *chryſolite.*

f. The yellowiſh green, and cloudy topaz, the *chryſopraſe* (A).

g. Bluiſh green topaz, or the beryl.

This varies in its colours; and is called, when

1. Of a ſea-green colour, the *aqua-marine.*
2. When more green, the *beryl.*

IV. Emerald. *Smaragdus gemma.*

Its chief colour is green and tranſparent. It is the ſofteſt of precious ſtones, and when heated it is phoſphoreſcent like the fluors.

V. To the precious ſtones belong alſo the jacinths, or hyacinths; which are cryſtals harder than quartz cryſtals, tranſparent, of a fine reddiſh-yellow colour when in their full luſtre, and formed in priſms pointed at both ends: theſe points are always regular, in regard to the number of the facets, being four on each point; but the facets ſeldom tally: the ſides alſo which form the main body, or column, are very uncertain in regard both to their number and ſhape; for they are found of four, five, ſix, ſeven, and ſometimes of eight, ſides: further, the column or priſm is in ſome alſo ſo compreſſed, as almoſt to reſemble the face of a ſpherical facetted garnet.

Mr Cronſtedt ſays, he got ſome jacinths of a quadrangular figure, which did not melt in the fire, but only became colourleſs.

VI. The amethyſt is a gem of a violet colour, with great brilliancy, and as hard as the beſt kind of rubies or ſapphires, from which it only differs by its colour. This is called the *oriental amethyſt;* and is very rare: when it inclines to the purple, or roſy colour, it is more eſteemed than when it is nearer to the blue.

Theſe amethyſts have the ſame figure, hardneſs, ſpecific gravity, and other qualities, as the beſt ſapphires or rubies; and come from the ſame places, particularly from Perſia, Arabia, Armenia, and the Weſt Indies.

The amethyſts called *occidental,* are of the ſame nature as rock cryſtals, and have the ſame gradations. viz. of a violet inclining to the purple

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(A) In the *Annals of Chemiſtry*, Vol. I. we have the following account of the method of digging for the chryſopraſus, and of the earths and ſtones with which it is accompanied.

This precious ſtone is found in certain mountains in Sileſia, which ſeem to begin thoſe of Tradas, extending to within half a league of Glatz. Theſe mountains appear, in general, to conſiſt of a number of ſtrata, horizontal or inclined, compoſed chiefly of ſubſtances containing magneſia, but likewiſe mixed with calcareous, argillaceous, and ſiliceous earths. The greateſt part of theſe conſiſt of ſerpentine, mixed with aſbeſtos and amianthus, grey argillaceous earths, boles, and red or green ochres, ſtone marrow, ſteatites, or ſoapſtone, and talc. In thoſe mountains alſo we meet with quartz, petroſilex, opal, and chalcedony, in detached fragments, and ſometimes in continued veins. We alſo diſcover in them veins of ſand, of the nature of granite. Sometimes the ſerpentine is met with at the ſurface; ſometimes at the depth of 20 or 30 feet. The ſtone marrow ſeems here to be produced by the decompoſition of a very milky ſpecies of opal agate named *cacholong;* for at the depth of 50 feet and upwards the veins of this ſoapy earth aſſume a degree of ſolidity, and we find nothing but hard and ſemitranſparent cacholongs.

The above-mentioned ſtrata are croſſed by a great number of cracks filled with green-coloured earths and ſtones; but theſe frequently do not contain a ſingle true chryſopraſus. They are ſometimes found immediately under the vegetable mould, or at the depth of ſome feet, in ſhapeleſs maſſes, covered with a heavy clay, and ſometimes enveloped by an unctuous earth of a beautiful green colour, which it derives from the calx of nickel. In other places, the chryſopraſus has been found in uneven laminæ of ſeveral yards in length and breadth, either immediately under the mould, or in the upper ſtrata of ſerpentine, which have little ſolidity; and very beautiful ones have been found at the depth of ſeven or eight fathoms; and ſome have been met with in grey clay at the depth of four fathoms. In ſome places alſo they are met with in a kind of red ochre, which is attracted by the magnet; in others they are found in the clefts of rocks. The beautiful green chryſopraſus is found moſt plentifully in the mountain of Glaſſendorf. In another mountain named Koſmutz, where it is alſo found, the pieces are ſo porous, and ſo much ſpotted with white, &c. that ſometimes upwards of 1000 of them have not afforded one large enough for the uſe of the jewellers. The defects are frequently only diſcoverable on poliſhing, as the green opal, while rough, perfectly reſembles the chryſopraſus; but, on poliſhing the ſtones in which it is contained, it is detected by its want of luſtre.

The quantity in which theſe ſtones are found is not ſufficient to afford the expences of regular mining; the moſt profitable way, therefore, of obtaining them is by making trenches in the earth from four to ſix feet deep. Almoſt all the mountain of Koſemutz, however, has already been examined in this manner; ſo that they now dig for the chryſopraſus in quarries by uncovering a bank of earth or ſtone, and deſcending to other banks by ſteps in the open air, ſo as to throw the rubbiſh back from bank to bank. This method, however, cannot be continued farther than 24 or 30 feet, otherwiſe the produce would not defray the expence. The only tools employed in digging for the chryſopraſus are a ſpade and pick-ax; the former to remove the eart[illegible] the latter to detach the chryſopraſus itſelf from the ſtones which ſurround it.

Va[illegible]s accounts have been given of the component parts of this precious ſtone. Lehmann thinks, that the

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purple or rofy colour, or inclining to the blue; very often they are femi-tranfparent, without any colour in one end, and violet towards the other. The beft are found in the Vic mountains of Catalonia in Spain, and at Wiefenthal in Saxony, as well as in Bohemia in Germany, in Italy, and in the province of Auvergne in France.

Cryftals within the geodes, or hollow agatheballs, are very often found of an amethyft colour, and fome are very fine.

What we call *amethyft root*, or *mother of amethyft*, is but a fparry fluor, of which we have plenty in Derbyfhire: many fine ornamental pieces are made of this fubftance in different forms and fhapes. Thefe fpars are found in infulated maffes, fometimes pretty large; but never in the form of large rocks.

VII. The garnet, (*Granatus*.) This ftone, when tranfparent and of a fine colour, is reckoned among the gems: but it varies more than any, both in the form of its cryftals and in its colour, fome being of a deep and dark red, fome yellowifh and purplifh, and fome brown, blackifh, and quite opaque. In general, their luftre is lefs than that of other gems, as well as their hardnefs, which yields to the file, although they may ftrike fire with fteel. But as to their form, thefe cryftals take almoft all forts of figures, as the rhomboidal, tetradecaedral, &c. and fome are of an irregular form.

Their colour proceeds from the iron which enters into their compofition; and, according to M. de Sauffure, even the fineft oriental garnets attract the magnetic needle at a fmall diftance.

The Syrian garnet is the fineft and beft efteemed. It is of a fine red, inclining to the purple colour, very diaphanous, but lefs brilliant than the oriental amethyft. It feems to be the *amethyftizontas* of Pliny: the Italians call it *rubino di rocca*,

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the colour of it is owing to fome ferruginous particles modified in a particular manner: but the experiments he adduces for this opinion are not fatisfactory. Mr Sage attributes the colour to cobalt from the blue colour it imparts to glafs. Mr Achard thinks the ftone contains calx of copper as well as calx of iron; becaufe a part of the metal feparable from it may be diffolved in volatile alkali. The following are the experiments of M. Klaproth upon the fubject.

1. On heating feveral pieces of very pure chryfoprafus red hot, and quenching them in water, the colour was changed from green to bluifh grey; and, on repeating the operation, it became a white grey. They were found to have loft in weight one and an half per cent. and were eafily pulverable in a glafs mortar.

2. Three hundred grains of chryfoprafus were mixed with double its weight of mild mineral alkali, and the mixture heated for fome hours red hot, in a porcelain crucible. The mafs was then powdered, and digefted in diftilled water. By filtration, a yellowifh grey refiduum was obtained, weighing 44 grains; the filtered liquor was limpid and colourlefs, a copious precipitate being formed with muriatic acid, which being wafhed and dried was found to be filiceous earth.

3. The 44 grains of yellowifh grey refiduum were digefted in a retort, with 352 grains of aqua regia; a great part of which was evaporated. The acid which came over was returned into the retort, and filtered after a fecond digeftion. The refiduum was a very fine white filiceous earth, which, after being wafhed, dried, and heated red hot, weighed 20 grains.

4. The filtrated folution was of a pale green, but on fuperfaturation with volatile alkali immediately turned of a bluifh colour, precipitating a fmall quantity of brownifh gelatinous matter; which, when collected, twice diftilled with nitrous acid, and afterwards ftrongly heated, yielded a brown calx of iron, weighing no more than a quarter of a grain: whence our author concludes, that iron does not contribute to the colour of the chryfoprafus, as we know many colourlefs ftones which contain as great a quantity of that metal. This fmall quantity of calx was left after digefting the gelatinous refiduum. On precipitating the foluble parts, they appeared to confift of aluminous earth, in an exceffively divided ftate; which being wafhed and dried, weighed half a grain.

5. To find whether the folution contained calcareous earth or not, he mixed with that, fuperfaturated with volatile alkali, a faturated folution of mild mineral alkali, which precipitated four grains and an half of white and very pure calcareous earth.

6. Nothing more was precipitated from the folution, either by acids or alkalies, after the feparation of the calcareous earth, though it ftill retained a bluifh colour. It was poured into a retort, and evaporated to drynefs; the refiduum was of a yellowifh colour, which became green on being diffolved in diftilled water. Mild mineral alkali threw down only a little earth of a greenifh white colour; which being re-diffolved in dephlogifticated nitrous acid, and precipitated with Pruffian alkali, the liquor yielded 17 grains of a fea-green powder. This precipitate, in our author's opinion, is the colouring principle of the chryfoprafus; and this principle he afterwards found to be calx of nickel.

7. Our author likewife attempted to analyfe the chryfoprafus in the moift way by concentrated vitriolic acid; in which procefs his chief view was to difcover whether or not the ftone contained any volatile particles or not. On an ounce of crude chryfoprafus, therefore, when put into a retort, he poured an equal quantity of rectified vitriolic acid, and two parts of diftilled water. After the latter had paffed over into the receiver, the fire was increafed to force over the fuperabundant acid; a part arofe in white vapours, and fome fell into the receiver with an hiffing noife. Boiling water, which had been diftilled, was then poured upon the refiduum, and the folution filtered. The powdered chryfoprafus left on the filter had not been perfectly diffolved, and, in

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rocca, and is found in Syria, Calcutta, Cananor, Camboya, and Ethiopia.

The fine garnet of a red inclining to a yellow colour, is the *foranus* of the ancients, the *vermeille* of the French, and the *giacinto guarnacino* of the Italians. Its name is taken from *Sorian*, or *Surian*, a capital town of Pegu, from whence thefe gems are brought: when they have a brownifh taint, they are then called *hyacinths*.

The occidental garnet is of a deep and dark red, and its hardnefs is leffer. However, fome very fine hard garnets are found in Bohemia.—Garnets are alfo found in Hungary, at Pyrna in Silefia, at S. Sapho in the canton of Berne, in Spain, and in Norway.

The garnet melts in the focus of a good burning glafs into a brown mafs, which is attracted by the loadftone; and this fhows that iron enters confiderably into its compofition.

Some garnets are found, which contain a little gold. Thofe called *zingraupen* by the Germans contain tin.

VIII. Tourmalin; *Lapis electricus*.

This is a kind of hard ftone, lately brought

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into notice by its electrical properties. See TOURMALIN.

1. Its form is a prifm of nine fides of different breadths, moftly truncated, and feldom terminating in a pyramid at each end, which is either compofed of three pentagons, or of nine triangles.
2. When heated in the fire, it gives figns of contrary electricity on the two oppofite ends of their prifmatic form. But many of thefe ftones are not in the leaft electric. However, on being rubbed, they become electric in their fides, like other diaphanous gems.
3. It is as hard almoft as the topaz, and ftrikes fire with fteel.
4. It melts by itfelf in a ftrong fire, though with difficulty.
5. With the microcofmic falt it melts perfectly; but only in part with borax.
6. With mineral alkali it is divided into a kind of powder.
7. The three mineral acids diffolve it when firft reduced to a powder.
8. It bears a greater fimilarity to fchoerl than to any other ftone: but its component parts fhow

in general, had undergone but little alteration, fo that he could not by this method determine the component parts. M. Achard, however, was more fuccefsful, and by a fimilar method determined the component parts of this gem to be five grains of an earth, which, diftilled with vitriolic acid, became volatile; eight grains of calcareous earth, fix grains of magnefia, two grains of calx of iron, three grains of calx of copper, and 456 of filiceous earth.

M. Klaproth never met with any volatile earth or magnefia in his experiments on this gem; and therefore concludes, that the chryfoprafus ufed by him had been effentially different from that made ufe of by M. Achard; and he feems not to give credit to the account of any copper being found in it.

8. One part of crude chryfoprafus, well powdered and wafhed with two parts of mild vegetable alkali, yielded a violet-coloured glafs, which in the atmofphere ran into a brownifh-coloured liquor.

9. Five parts of the gem, with four of mild alkali, gave a beautiful violet-coloured glafs after being two hours in fufion.

10. Equal parts of crude chryfoprafus and mild mineral alkali, yielded a tranfparent glafs in thin laminæ, of a brown colour, refembling that of the tourmalin, the furface being marked with fine reticulated veins; which veins arofe from fmall grains of very fine reduced nickel placed in lines againft one another.

11. Equal parts of crude chryfoprafus and calcined borax, gave a clear, tranfparent, and brown glafs, refembling the fmoky topaz.

12. Equal parts of chryfoprafus, extracted by vitriolic acid and calcined borax, yielded a fimilar glafs of a clear brown colour; "which proves (fays our author), that the vitriolic acid was incapable of perfectly analyfing the chryfoprafus, though I had ufed a double portion of the earth."

13. Eighty grains of prepared filiceous earth, fixty grains of mild fixed alkali, with three grains of calx of nickel procured from the chryfoprafus, yielded a beautiful, clear, and violet-coloured glafs.

14. On fubftituting three grains of calx produced from an ore of nickel, a glafs was produced exactly like the former.

15. Sixty grains of prepared filiceous earth and calcined borax, with three grains of calx of nickel from the chryfoprafus, yielded a tranfparent glafs of a clear brown colour.

16. Sixty grains of prepared filiceous earth and vitrified phofphoric acid, with three grains of calx of nickel from the chryfoprafus, gave a glafs of the colour of honey.

17. Thus the attempts of M. Klaproth to recompofe the chryfoprafus proved abortive. From his experiments, however, he deduces the following conclufions: 1. The blue colour obfervable in the glafs produced by fufing the chryfoprafus with vegetable alkali, arifes entirely from the nickel contained in the gem; and the experiment fhows that the calx of nickel, when purified as much as poffible, has the furprifing property of tinging glafs frits prepared with vegetable alkali of a blue colour. "But (fays he) why was not this colour alfo obtained with foda? and what is the caufe of a difference fo little to be expected?" 2. By thefe experiments the fuppofition of M. Sage is refuted, that the metallic matter which colours the chryfoprafus is cobalt: "many metallic fubftances befides cobalt, it is well known, give by certain proceffes a blue glafs; thus cobalt,

ſhow that it may be ranged with propriety in this place, along with other precious ſtones: as the argillaceous earth is alſo the moſt prevalent in its compoſition.

a. The oriental tourmalines are found in the iſland of Ceylon. They are tranſparent, of a dark brown yellow; and their ſpecific gravity is from 3062 to 3295.

b. From Braſil. Tranſparent. Theſe are green for the moſt part; but there are alſo ſome red, blue, and yellow: their ſpecific gravity is from 3075 to 3180.

c. From Tyrol. Of ſo dark a green as to appear opaque. Their ſpecific gravity is about 3050. Theſe are found in beds of ſteatites and lapis-ollaris, among the micaceous veins, talcs. and hornblende of Schneeberg, Jurzagl, and Zillerthal, in the mountains of Tyrol.

d. From the mountains of Old Caſtile in Spain. Theſe are tranſparent, and have the ſame properties as the preceding ones.

IX. The opal, *Opalus;* the *giraſole* of the Italians.—This is the moſt beautiful of all the flint kind, owing to the changeable appearance of its colours by reflection and refraction, and muſt therefore be deſcribed under both theſe circumſtances.

1. The opal of Nonnius, the *Sangenon* of the Indians. This appears olive-coloured by reflection, and ſeems then to be opaque; but when held againſt the light, is found tranſparent and of a fine ruby red colour.

There is, however, another of the ſame kind in Sweden, which by reflection appears rather brown; but by refraction it is red, with violet veins.

2. The white opal. Its ground is white, of a glaſs-like complexion, from whence are thrown out green, yellow, purple, and bluiſh rays; but it is of a reddiſh or rather flame-colour when held againſt the light.

a. Of many colours; the oriental opal.

b. Of a milky colour.

c. Bluiſh, and ſemi-tranſparent. This is not ſo much valued as thoſe which are more opaque, becauſe it is eaſier to be imitated by art.

§ 2. *Of Quartz.*

This ſtone is very common in Europe, and eaſier to be known than deſcribed. It is diſtinguiſhed from the other kinds of the ſiliceous order by the following qualities.

1. That it is moſt generally cracked throughout, even in the rock itſelf; whereby,
2. As well as by its nature, it breaks irregularly, and into ſharp fragments.
3. That it cannot eaſily be made red-hot without cracking ſtill more.
4. It never decays in the air.
5. Melted with pot-aſhes, it gives a more ſolid and fixed glaſs than any other of the ſiliceous order.
6. When there has been no interruption in its natural accretion, its ſubſtance always cryſtalliſes into hexagonal priſms pointed at one or both ends.
7. It occurs in clefts, fiſſures, and ſmall veins in rocks. It very ſeldom forms large veins, and ſtill ſeldomer whole mountains, without being mixed with heterogeneous ſubſtances.

According to Mr Kirwan, quartz neither loſes its hardneſs nor its weight by calcination. Its texture is lamellar. Theſe ſtones are in general the pureſt of the ſiliceous kind, though moſt contain a ſlight mixture of other earths; the moſt obvious diſtinction among them ariſes from their tranſparency or opacity.

Quartz is found,

(1.) Pure.

A. Solid, of no viſible particles, with a gloſſy ſurface. Fat quartz.

a. Uncoloured and clear. This has no cryſtalliſed form, but is nevertheleſs as clear as quartz cryſtals of the beſt water.

b. White, the common fat quartz.

c. Blue

cobalt gives a blue colour to combinations of the mineral alkali with phoſphoric acid, to mineral alkali itſelf, to potaſh, and to borax. The acid of tungſten (falſely ſo called) alſo gives a blue colour to frits made with phoſphoric ſalts, but not to thoſe made with borax; the calx of nickel gives a blue colour only to frits made with potaſh, brown to thoſe with mineral alkali and borax, and yellow, like honey, to combinations of phoſphoric acid with mineral alkali." 3. As the chryſopraſus gives a brown colour with borax, and the ſolution of this ſtone in muriatic acid gives no ſigns of cobalt diſſolved in the ſame acid; this ſhows that there is no cobalt in the ſtone. Mr Sage, indeed, pretends, that he has obtained a blue glaſs from the chryſopraſus and borax; but this is contradicted by experience. 4. The mineralogical character of the chryſopraſus, therefore, is a quartz coloured green by nickel. Three hundred grains of it contain 288¼ of ſiliceous earth calcined to redneſs, one quarter of a grain of pure aluminous earth, two grains and an half of calcareous earth calcined to redneſs, three grains of calx of nickel, and one quarter of a grain of calx of iron. All theſe were extracted in the experiments; and there were beſides five grains and an half of waſte.

Our author mentions, that in the collections of chryſopraſus which have been brought to him, he has conſtantly obſerved green opal, in bits of vein from half an inch to an inch, and fixed in its borders: the reddiſh, yellow, and white opals, on the contrary, are generally met with on a green or browniſh petroſilex But the white opal, which, as well as the green, is found in pieces of the nature of matrix, differs from the true opal, approaching the chalcedony and the opaque milky quartzes. This kind of tranſparent opal, radiated with a whitiſh blue, contains the following ingredients in its compoſition: Siliceous earth, 237 grains; aluminous earth, a quarter of a grain; calx of iron, a quarter of a grain—in all, 237½ grains. In 240 grains were two and an half of waſte. The colour of this ſtone, as well as the chryſopraſus, in our author's opinion, is derived from nickel.

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c. Blue.
d. Violet.
B. Grained.
a. White. *b.* Pale green.
C. Sparry quartz.

This is the fcarceft; and ought not to be confounded with the white felt-fpat, being of a fmoother appearance, and breaking into larger and more irregular planes.

a. Whitifh yellow. *b.* White.
D. Cryftallifed quartz. Rock cryftal. Quartz cryftal.
1. Opaque, or femi-tranfparent.
a. White, or of a milk colour.
b. Red, or of a carnelian colour.
c. Black.
2. Clear.
a. Blackifh brown, fmoky topaz, or *raunch topaz* of the Germans.
b. Yellow; found in Bohemia, and fold inftead of topazes.
c. Violet; the amethyft from Saxony, Bohemia, and Dammemore in Upland (B.)
d. Uncoloured; rock cryftal, properly fo called. When thefe coloured cryftals are not clear, they are called *flufs;* for inftance, *topaz-flufs*, *amethyft-flufs*, &c. (C.)

(2.) Impure quartz.
A. Mixed with iron, in form of a black calx.—This is of a gloffy texture, and contains a great quantity of iron.
B. Mixed with copper in form of a red calx.
a. Red.

§ 3. *Of Flints.*

The flint (*Silex pyromachus*, *Lapis corneus*, or the *hornftein* of the Germans) forms a kind of intermediate fubftance between quartz and jafper; both which, however, it fo nearly refembles, that it is not eafy to point out fuch characters as fhall readily diftinguifh it from them. We can only, therefore, fpeak of its properties comparatively.

1. It is more uniformly folid, and not fo much cracked in the mafs as the quartz; and,
2. It is more pellucid than the jafper.
3. It bears being expofed to the air without decaying better than the jafper, but not fo well as the quartz.
4. It is better for making of glafs than the jafper, but is not quite fo good as quartz for that purpofe.
5. Whenever there has been an opportunity in this matter of its fhooting into cryftals, quartz cryftals are always found in it; juft as if the quartz made one of its conftituent parts, and had in certain circumftances been fqueezed out of it: this is to be feen in every hollow flint, and its clefts, which are always filled up with quartz.
6. It often fhows moft evident marks of having been originally in a foft and flimy tough ftate like glue or jelly.

The feveral varieties of this fpecies have obtained more diftinct names with refpect to their colours than from any real difference in their fubftance; but thefe are ftill neceffary to be retained, as the only names ufed by jewellers and others, who know how to value them accordingly.

I. Jade. *Lapis nephriticus. Jafpachates.*

The true lapis nephriticus feems to belong to this filiceous order, as it gives fire with fteel, and is femi-pellucid like flint; it does not harden

(B) The moft tranfparent are called *falfe diamonds*, *Briftol*, *Kerry ftones*, and *Alençon diamonds*, &c. The coloured tranfparent cryftals derive their tinge generally from metallic calces, though in exceeding fmall portions: they all lofe their colours when ftrongly heated. Thefe are what we call falfe gems, viz.

The *red*, from Oran in Barbary, *falfe rubies.*
The *yellow*, from Saxony, *falfe topazes.*
The *green*, from Dauphiny, (very rare) *falfe emeralds*, or *prafes.*
The *violet*, from Vil in Catalonia, *falfe amethyfts.*
The *blue*, from Puy in Valay, France, *falfe fapphires.*

There are alfo *opal*, or *rainbow cryftals*, fome of which make a very fine appearance; the various colours of which are thrown out in zones acrofs the furface, though they never fhine like the oriental opal.

(C) M. Fourcroy makes a remarkable difference between the cryftals and the quartz, by affirming that the former are unalterable in the fire, in which they neither lofe their hardnefs, tranfparency, nor colour; whilft the quartz lofes the fame qualities, and is reduced by it to a white and opaque earth. He claffes the rock cryftals,

1ft, According to their *form*, viz. 1. Infulated-hexagonal-cryftals, ending in two pyramids of fix faces, which have a double refraction, or fhow two images of the fame object when looked through. 2. Hexagonal cryftals united, having one or two points. 3. Tetrædral, dodecædral, flated cryftals; and which, though hexagonal, have neverthelefs their planes irregular. 4. Cryftals in large maffes, from the ifland of Madagafcar, which have a fimple refraction.

2dly, As to the colour, they are either diaphonous, reddifh, fmokey, or blackifh.

3dly, As to accidental changes, fome are *hollow:* fome contain *water* within one or more cavities: fome arc cafed, viz. one within the other: fome are of a round form, as the pebbles of the Rhine: fome have a cruft of metallic calces, or of a pyrites: fome are of a geodical form, viz. cryftallifed in the infide of a cavity: fome feem to contain amianthe, or afbeftus, and others contain fhirls.

The fame author reckons among cryftals, the oriental topaz, the hyacinth, the oriental fapphire, and the amethyft. Mr Daubenton has always looked on this laft as a quartzous cryftal.

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den in fire, but melts by the solar heat in the focus of a burning lens into a transparent green glass with some bubbles. That called by the name of *circoncision stone*, which comes from the Amazon river, melts easier, in the same solar fire, into a brown opaque glass, which is far less hard than the stone itself. (*Macquer.*)

This stone is superior in hardness to quartz, though from its unctuosity to the touch, one would suspect it to contain a large portion of argillaceous earth, or rather of magnesian earth, as Mr Kirwan seems to suspect.

Its specific gravity is from 2,970 to 3,389.—It is of a granular texture, of a greasy look, and exceedingly hard: is scarcely soluble in acids, at least without particular management, and is infusible in the fire. M. Saussure seems to have extracted iron from it.

a. It is sometimes of a whitish milky colour, from China; but mostly

b. Of a greenish, or

c. Deep-green colour, from America.

d. Grey, yellowish, and olive colour: these are the vulgar *lapis nephriticus*, they being supposed to cure the nephritic pains by their external application to the loins.

The semi-pellucidity, hardness, and specific gravity, are the characters by which the lapis nephriticus may be distinguished from other stones.

II. Cat's eye; *Pseudopalus.* The sun-stone of the Turks, called *guneche.*

This stone is opaque, and reflects green and yellowish rays from its surface: it is found in Siberia. It is very hard and semi-transparent, and has different points, from which light is reflected with a kind of yellow-brown radiation, somewhat similar to the eyes of cats, from whence it had its name. Jewellers do not fail to cut them round to the greatest advantage. The best of these stones are very scarce. One of these of one inch diameter was in the cabinet of the grand duke of Tuscany.

III. *Hydrophanes*, or *Oculus Mundi;* also called *Lapis mutabilis.*

The principal property which distinguishes this from all other stones, is that it becomes transparent by mere infusion in any aqueous fluid; but it gradually resumes its opacity when dry.

IV. The onyx. *Onyx camehuja.* Memphites. It is found of two sorts.

a. Nail-coloured onyx, having pale flesh-coloured and white lines.

b. With black and white lines. The oriental onyx.

V. The chalcedony, or white agate, is a flint of a white colour, like milk diluted with water, more or less opaque: it has veins, circles, and round spots. It is said to be softer than the onyx, but much harder than those agates which are sometimes found of the same colour.

a. The white opaque chalcedony, or *cahólong*, from the Buckharish Calmucks. This was first made known by one Renez, a Swedish officer, who for several years had been in that country. The inhabitants find this flint on the banks of their rivers, and work idols and domestic vessels out of it.

b. Of white and semi-transparent strata; from Ceylon.

c. Bluish grey; from Ceylon and Siberia.

VI. The carnelian. *Carniolus.*

Is of a brownish red colour, and often entirely brown. Its name is originally derived from its resemblance to flesh, or to water mixed with blood.

a. Red.

b. Yellowish brown, looks like yellow amber. It is said not to be so hard as the chalcedony.

VII. The sardonyx.

This is a mixture of the chalcedony and carnelian, sometimes stratumwise, and sometimes confusedly blended and mixed together.

a. Striped with white and red strata: this serves as well cut in cameo as the onyx.

b. White, with red dendritical figures. This very much resembles that agate which is called the *mocha stone;* but with this difference, that the figures are of a red colour in this, instead of black, as in that agate.

Between the onyx, carnelian, chalcedony, sardonyx, and agate, there seems to be no real difference, except some inexplicable degrees of hardness.

VIII. The agate; *Achates.*

This name is given to flints that are variegated with different colours, promiscuously blended together; and they are esteemed in proportion to their mixture of colours, their beauty, and elegance. Hence also they have obtained variety of names, mostly Greek, as if the business of the lapidary in cutting of them, and admiring their several beauties and figures, had been derived from that nation alone (D).

a. Brown opaque agate, with black veins, and dendritical figures; the Egyptian pebble.

b. Of a chalcedony colour; *achates chalcedonisans.*

c. Semi-transparent, with lines of a blackish brown colour, and dendritical figures; the mocha stone.

d. Semi-transparent, with red dots; *Gemma divi Stephani.* When the points are very minute, so as to give the stone a red appearance, it is by some called *Sardea.*

(D) On the side of a hill near the church of Rothes in Moray, is a quantity of fine agate of elegant red and white colours. It is very hard, heavy, of a smooth uniform texture, and of a considerable brightness; in which the red are remarkably clear, and finely mixed and shaded through the stone. Mr Williams says that this is the largest and most beautiful agate rock he ever saw; and so fine and hard as to be capable of the highest lustre in polishing.

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e. Semi-tranſparent, with clouds of an orange colour.
f. Deep red or violet, and ſemi-tranſparent.
g. Of many colours, or variegated.
h. Black.

IX. Common Flint; *Pyromachus*.

This, in reality, is of the ſame ſubſtance as the agate; but as the colours are not ſo ſtriking or agreeable, it is commonly conſidered as a different ſubſtance.

a. Blackiſh grey, from the province of Skone.
b. Yellow ſemi-tranſparent, from France.
c. Whitiſh grey.
d. Yellowiſh brown.

When the flints are ſmall, they are in England called *pebbles*; and the Swediſh ſailors, who take them as ballaſt, call them *ſingel*.

X. Chert; *Petroſilex*, *Lapis Corneus*. The *hornſtein* of the Germans.

This is of a coarſer texture than the preceding, and alſo leſs hard, which makes it conſequently not ſo capable of a poliſh. It is ſemi-tranſparent at the edges, or when it is broke into very thin pieces.

a. Chert of a fleſh colour, from Carl-Schakt, at the ſilver-mine of Salberg, in the province of Weſtmanland.
b. Whitiſh yellow, from Salberg.
c. White, from Kriſtierſberg, at Nya Kopparberget in Weſtmanland.
d. Greeniſh, from Preſtgrufvan, at Hellefors in Weſtmanland.

Chert runs in veins through rocks, from whence its name is derived. Its ſpecific gravity is from 2590 to 2700. In the fire, it whitens and decrepitates like ſilex, but is generally ſo fuſible as to melt *per ſe*. It is not totally diſſolved in the dry way by the mineral alkali; but borax and microcoſmic ſalt diſſolve it without effervefcence. Its appearance is duller and leſs tranſparent than common flint. The reddiſh Petro-ſilex uſed in the Count de Lauragar's porcelain manufacture, and called there *felt ſpat*, contained 72 *per cent.* of ſilex, 22 of argill, and 6 of calcareous earth.

There are not yet any certain characters known by which the cherts and jaſpers may be diſtinguiſhed from each other: by ſight, however, they can eaſily be diſcerned, viz. the former (the cherts) appearing tranſparent, and of a fine ſparkling texture, on being broken; whereas the jaſper is grained, dull, and opaque, having the appearance of a dry clay. The chert is alſo found forming larger or ſmaller veins, or in nodules like kernels in the rocks; whereas the jaſper, on the contrary, ſometimes conſtitutes the chief ſubſtance of the higheſt and moſt extended chain of mountains. The chert is likewiſe found plentifully in the neighbourhood of ſcaly limeſtone, as flints in the ſtrata of chalk. What connection there may be between theſe bodies, perhaps time will diſcover.

But flints and agates being generally found in looſe and ſingle irregular nodules, and hardly in rocks, as the chert, it is a circumſtance very inſufficient to eſtabliſh a difference between them; for there is the agate-ſtone, near Conſtantinople, running vein-like acroſs the rock with its country of the ſame hardneſs, and as fine and tranſparent as thoſe other agates which are found in round nodules at Deux-ponts. We muſt, therefore, content ourſelves with this remark concerning flints, viz. That they ſeem to be the only kind of ſtone hitherto known, of which a very large quantity has been formed in the ſhape of looſe or ſeparate nodules, each ſurrounded with its proper cruſt; and that the matter which conſtitutes this cruſt has been ſeparated from the reſt of the ſubſtance, in like manner as ſandiver or glaſs-gall ſeparates from, and ſwims upon, glaſs, during its vitrification; though ſometimes the formation of this cruſt may be prevented by the too ſudden hardening of the matter itſelf.

Other ſpecies of ſtones, which are found in looſe pieces or nodules, except ores and ſome ſorts of ſtalactites, ſhow evidently by their cracks, angles, and irregular figures, that they have been torn from rocks, rolled about, and rubbed againſt one another in torrents, or by ſome other violent motions of water.

That flints had originally been in a ſoft ſtate, M. Cronſtedt obſerves, is eaſy to be ſeen in the Egyptian pebbles, which have impreſſions of ſmall ſtones, ſand, and ſometimes, perhaps, graſs; which, however, have not had any ingreſs into the very flint, but ſeem only to have forced the above agate-gall or cruſt out of the way.

§ 4. *Of Jaſpers.*

Jasper, *jaſpis*, (the *diaſpro* of the Italians), is a name given to all the opaque flints whoſe texture reſembles dry clay, and which have no other known quality whereby they may be diſtinguiſhed from other flints, except that they may be more eaſily melted in the fire; and this quality perhaps may proceed from the heterogeneous mixture, probably of iron.

I. Pure jaſper; which by no means yet known can be decompounded.

a. Green with red ſpecks or dots; the *heliotrope*, or blood-ſtone. *b*. Green. *c*. Red. *d*. Yellow. *e*. Red with yellow ſpots and veins. *f*. Black.

II. Jaſper containing iron; *Jaſpis martialis Sinople*.

A. Coarſe-grained.

a. Red and reddiſh brown; *ſinople*.

B. Steel-grained, or fine-grained.

a. Reddiſh brown: looks like the red ochre or chalk uſed for drawing; and has partition veins, which are unctuous to the touch, like a fine clay, and other like kinds.

C. Of a ſolid and ſhining texture, like a flag.

a. Liver-coloured; and, *b*. Deep red. *c*. Yellow. This laſt mentioned, when calcined, is attracted by the loadſtone; and being aſſayed, yields from 12 to 15 *per cent.* of iron. (E.)

§ 5.

(E) Near Portſoy in Banff-ſhire is an extenſive rock of jaſper; ſome parts of which contain a beautiful mixture of green and red, which appear finely ſhaded and clouded through the body of the ſtone when poliſhed. Mr Williams is of opinion that it would be a very valuable quarry if worked.

§ 5. *Felt-spars.*

I. Rhombic quartz; *Spatum scintillans.*

This has its name from its figure, but seems to be of the same substance as the jasper. We have not, however, ranked them together, for want of true marks to distinguish the different sorts of the flinty tribe from one another.

This kind is found,

1. Sparry.
   a. White. *b.* Reddish brown. *c.* Pale yellow. *d.* Greenish.
2. Crystallised.
   a. In separate or distinct rhomboidal crystals.

II. Labradore stone; *Spatum rutilum versicolor.*

Its colour is commonly of a light or of a deep grey, and mostly of a blackish grey: but when held in certain positions to the light, discovers different varieties of beautiful shining colours, as lazuly-blue, grass-green, apple green, pea-green; and seldom a citron-yellow; some have an intermediate colour betwixt red-copper and tombac-grey; besides other colours between grey and violet. These colours are seen for most part in spots; but sometimes in stripes, on the same piece.

III. White feltspar; *Terra Silicea Magnesia & ferro intime mixta.*

This stone has been described by Mr Bayen: and is found at St Marie aux mines in Lorrain. —It is of a white opaque colour, spotted with ochre on the outside.

§ 6. *Of the Garnet Kinds.*

The substances of this *genus* (which is considered by Cronstedt as an *order*) are analogous to gems; since all these are composed of the siliceous, calcareous, and argillaceous earths, with a greater or less proportion of iron. The opaque and black garnets contain about 20 hundredths of iron: but the diaphanous ones only two hundredths of their weight, according to Bergman. The garnets, properly so called, contain a greater quantity of siliceous earth than the shirls, and both are now justly ranked with the siliceous earths.

The species are,

I. Garnet; *Granatus.*

This is a heavy and hard kind of stone, crystallising in form of polygonal balls, and mostly of a red, or reddish brown colour.

A. Garnet mixed with iron; *Granatus martialis.*

1. Coarse-grained garnet-stones, without any particular figure; in Swedish called *Granatberg*; in German, *Granatstein.*
   a. Reddish-brown garnet. *b.* Whitish-yellow. *c.* Pale yellow.
2. Crystallised garnet.
   a. Black. *b.* Red: semi-transparent, and cracked; transparent. *c.* Reddish-yellow; transparent; the jacinth, or hyacinth. *d.* Reddish brown. *e.* Green. *f.* Yellowish-green. *g.* Black.

B. Garnet mixed with iron and tin.

1. Coarse-grained, without any particular figure.
   a. Blackish-brown.
2. Crystallised.
   a. Blackish-brown.
   b. Light-green or white.

C. Garnet mixed with iron and lead.

1. Crystallised.
   a. Reddish-brown.

II. Cockle, or shirl. *Corneous crystallisatus Wallerii; Stannum crystallis columnaribus nigris Linnæi.*

This is a heavy and hard kind of stone which shoots into crystals of a prismatical figure, and whose chief colours are black or green. Its specific gravity is the same as the garnets, viz. between 3000 and 3400, though always proportionable to their different solidity.

A. Cockle, or shirl, mixed with iron.

1. Coarse, without any determined figure.
   a. Green,
2. Sparry.
   a. Deep green, (the mother of the emeralds), from Egypt.
   b. Pale green.
   c. White. This occurs very frequently in the scaly limestones; and its colour changes from deep green to white, in proportion as it contains more or less of iron.
3. Fibrous, striated cockle, or shirl: it looks like fibres or threads made of glass.
   A. Of parallel fibres. *a.* Black. *b.* Green *c.* White.
   B. Of concentrated fibres: The starred cockle, or shirl, from its fibres being laid stellarwise.
   a. Blackish green. *b.* Light green. *c.* White.
4. Crystallised cockle, or shirl.
   a. Black. To this variety belong most of those substances called *imperfect asbesti*; and as the cockle perfectly resembles a slag from an iron furnace, both in regard to its metallic contents and its glassy texture, it is no wonder that it is not soft enough to be taken for an asbestus. It has, however, only for the sake of its structure, been ranked among the asbesti. The striated cockle, or shirl, compared to the asbesti, is of a shining and angular surface (though this sometimes requires the aid of the magnifying-glass to be discovered), always somewhat transparent, and is pretty easily brought to a glass with the blow-pipe, without being consumed as the pure asbesti seem to be.
   b. Deep green.
   c. Light green.
   d. Reddish brown. The *tauffstein* is of this colour, and consists of two hexagonal crystals of cockle grown together in form of a cross; this the Roman Catholics wear as an amulet, and is called in Latin *lapis crucifer*, or the cross stone.

The figure of the cockle crystals is uncertain, but always prismatical: the cockle from Yxsio at Nya Kopparberg, is quadrangular: the French kind has nine sides or planes; and the tauffstein is hexagonal.

The name *cockle* for these substances is an old Cornish mineral name; but is also given sometimes to other very different matters.

We

Siliceous Earths. Gems.

We have not in England any great quantity of fpecies of cockles; the chief are found in the tin mines of Cornwall, and fome fine cryftallifed kinds have been brought from Scotland.

The Englifh mineral name of *call*, has been ufed by fome authors as fynonymous with *cockles*, and they are confounded together at the mines; but the call, definitely fpeaking, is the fubftance called *wolfram* by the Germans, &c.

Garnets, though fmall, are often found in micaceous ftones in England; but extreme good garnets are found in great plenty alfo in like ftones in Scotland.

III. Rowley rag, (*Kirwan.*) This ftone is of a dufky or dark grey colour, with numerous minute fhining cryftals. Its texture is granular: by expofure to the air it acquires an ochry cruft. Its fpecific gravity is 2748. Heated in an open fire it becomes magnetic. In ftrong heat it melts *per fe*, but with more difficulty than bafaltes. According to Dr Withering's analyfis, 100 parts of it contain 47,5 of filiceous earth, 32,5 of argil, and 20 of iron.

IV. Siliceous muriatic fpar, (*Id.*) This ftone is of a hard, folid, and fparry texture; of a grey, ochry, dull colour, but internally bright. It gives fire with fteel: yet it effervefces with acids. In a ftrong heat it grows brown; but at laft it melts *per fe*. One hundred parts of this ftone contain fifty parts of filex: the remainder is mild magnefia and iron; but in what proportion is not mentioned (See *Journal de Phyfique*, Supplement, vol. xiii. p. 216.)

V. Turky ftone; *cos Turcica*, (*Id.*) This ftone is of a dull white colour, and often of an uneven colour, fome parts appearing more compact than others, fo that it is in fome meafure fhattery. It is ufed as a whetftone: and thofe of the fineft grain are the beft hones for the moft delicate cutting tools, and even for razors, lancets, &c. Its fpecific gravity is 2598. It gives fire with fteel; yet effervefces with acids. Mr Kirwan found that 100 parts of it contains 25 of mild calcareous earth, and no iron. There probably are two forts of ftones known by this name, as Mr Wallerius affirms, that which he defcribes neither to give fire with fteel nor effervefce with acids.

VI. Ragg ftone. The colour of this ftone is grey. Its texture is obfcurely laminar, or rather fibrous, but the laminæ or fibres confift of a congeries of grains of a quartzy appearance, coarfe and rough. Its fpecific gravity is 2729. It effervefces with acids; and gives fire with fteel. Mr Kirwan found it to contain a portion of mild calcareous earth, and a fmall proportion of iron. It is ufed as a whet-ftone for coarfe cutting tools.

[The filiceous grit, *cos arenarius*, and other compounds of the filiceous earth, &c. will be found in a fubfequent divifion of this article.]

Obfervations on the œconomical Ufes of the Siliceous Order.

The Europeans have no farther trouble with the precious ftones than either to cut them from their natural or rough figure, or to alter them when they have been badly cut in the Eaft Indies; in which latter circumftances they are called *labora*: and it may be obferved, that for cutting the ruby, fpinell, ballas, and chryfolite, the oil of olive is required, inftead of any other liquid, to be mixed with the diamond powder, in the fame manner as for cutting the diamond itfelf.

If the petty princes in thofe parts of the Indies, where precious ftones are found, have no other power nor riches proportionable to the value of thefe gems, the reafon of it is as obvious as of the general weaknefs of thofe countries where gold and filver abound, *viz.* becaufe the inhabitants, placing a falfe confidence in the high value of their poffeffions, neglect ufeful manufactures and trade, which by degrees produces a general idlenefs and ignorance through the whole country.

On the other hand, perhaps, fome countries might fafely improve their revenues by fuch traffic. In Saxony, for example, there might probably be other gems found befides aqua marines and topazes; or even a greater trade carried on with thefe than at prefent, without danger of bad confequences, efpecially under the direction of a careful and prudent government.

The *half-precious* ftones, fo called, or gems of lefs value, as the common opal, the onyx, the chalcedony, the cornelian, and the coloured and colourlefs rock cryftals, have been employed for ornaments and economical utenfils, in which the price of the workmanfhip greatly exceeds the intrinfic value of the ftones. The ancients ufed to engrave concave and convex figures on them, which now-a-days are very highly valued, but often with lefs reafon than modern performances of the fame kind. Thefe ftones are worked by means of emery on plates and tools of lead, copper, and tin, or with other inftruments; but the common work on agates is performed at Oberftein with grind-ftones at a very cheap rate. When once fuch a manufactory is eftablifhed in a country, it is neceffary to keep it up with much induftry and prudence, if we would wifh it to furmount the caprice of fafhions; fince, howmuchfoever the natural beauties of thefe ftones feem to plead for their pre-eminence, they will at fome periods unavoidably fink in the efteem of mankind; but they will likewife often recover, and be reftored to their former value.

The grindftones at Oberftein are of a red colour, and of fuch particular texture, that they neither become fmooth, nor are they of too loofe a compofition.

Moft part of the flinty tribe is employed for making glafs, as the quartz, the flints, the pebbles, and the quartzofe fands. The quartz, however, is the beft; and if ufed in due proportion with refpect to the alkali, there is no danger of the glafs being eafily attacked by the acids, as has fometimes happened with glafs made of other fubftances, of which we had an inftance of bottles filled with Rhenifh and Mofelle wines during the time of a voyage to China.

In the fmelting of copper ores, quartz is ufed, to render the flag glaffy, or to vitrify the iron; quartz being more ufeful than any other ftone to prevent the calcination of the metal.

The quartzofe fand which conftitutes part of many ftones, and is alfo ufed in making crucibles and fuch veffels,

vessels, contributes most of all to their power of resisting fire.

It appears likewise probable that the quartzose matter makes the grind and whetstone fit for their intended purposes. (*Magellan.*)

Order V. *The* Argillaceous Earths.

The principal character whereby those may be distinguished from other earths is, that they harden in the fire, and are compounded of very minute particles, by which they acquire a dead or dull appearance when broken.

I. *Argilla aerata ; lac lunæ.*

This fanciful name was heretofore thought to denote a very fine species of calcareous earth; but Mr Screber has lately shown, that the earth to which this name is given, is a very uncommon species of argill. It is generally found in small cakes of the hardness of chalk ; and like that, it marks white. Its hardness is nearly as that of steatites, and it does not feel so fat as common clay does. Its specific gravity is 1669 ; its colour snow white. When examined with a microscope, it is found to consist of small transparent crystals ; and by his experiments it appears plainly to be an argill saturated with fixed air. It effervesces with acids, and contains a very small proportion of calcareous earth and sometimes of gypsum, besides some feeble traces of iron. It is found near Halles.

II. Porcelain clay ; *Terra porcellanea*, vulgo *Argylla apyra*, very refractory ; the *kaolin* of the Chinese.

(1.) Pure.

A Diffusible in water.

1. Coherent and dry.

a White.

2. Friable and lean.

a. White.

(2.) Mixed with phlogiston

A. Diffusible in water.

a. White and fat pipeclay. *b.* Of a pearl colour. *c.* Bluish grey. *d.* Grey. *e.* Black. *f.* Violet.

These contain a phlogiston, which is discovered by exposing them to quick and strong fire, in which they become quite black interiorly, assuming the appearance of the common flints, not only in regard to colour, but also in regard to hardness : but if heated by degrees, they are first white, and afterwards of a pearl colour. The fatter they seem to be, which may be judged both by their feeling smooth and unctuous, and by their shining when scraped with the nail, they contain a larger quantity of the inflammable principle. It is difficult to determine, whether this strongly inherent phlogiston be the cause of the above-mentioned pearl-colour, or prevents them from being burnt white in a strong fire ; yet no heterogeneous substance can be extracted from them, except sand, which may be separated from some by means of water ; but which sand does not form any of the constituent parts of the clays. If they be boiled in aqua regis in order to extract any iron, they are found to lose their viscosity.

III. Stone-marrow ; *Lithomarga. Keffekil* of the Tartars.

1. When dry, it is as fat and slippery as soap ; but,
2. Is not wholly diffusible in water, in which it only falls to pieces, either in larger bits, or resembles a curd-like mass.
3. In the fire it easily melts to a white or reddish frothy slag, consequently is of a larger volume than the clay was before being fused.
4. It breaks into irregular scaly pieces.

A. Of coarse particles : Coarse stone-marrow.

a. Grey.

b. Whitish yellow, from the Crim Tartary, where it is called *keffekil*, and is said to be used for washing instead of soap.

B. Of very fine particles ; fine stone-marrow.

a. Yellowish brown ; *Terra Lemnia.*—Is of a shining texture, falls to pieces in the water with a crackling noise ; it is more indurated than the preceding, but has otherwise the same qualities.

IV. Bole, (iron clay.)

This is a fine and dense clay of various colours, containing a great quantity of iron, which makes it impossible to know the natural and specifical qualities of the bole itself, by any easy method hitherto in use. It is not easily softened in water, contrary to what the porcelain and the common clays are, (I. & VI.) ; but either falls to pieces in form of small grains, or repels the water, and cannot be made ductile. In the fire it grows black, and is then attracted by the loadstone.

A. Loose and friable boles, or those which fall to a powder in water.

a. Flesh-coloured bole.

b. Red.

1. Fine ; *Bolus Armenus.*
2. Coarse ; *Bolus communis officinalis.*
3. Hard : *Terra rubrica.*

c. Green ; *Terre verte.*

1. Fine.
2. Coarse.

d. Bluish-grey, is ductile as long as it is in the rock, but even then repels the water ; it contains 40 per cent. of iron ; which metal being melted out of it in a close vessel, the iron crystallises on its surface.

e. Grey.

1. Crystallised in a spherical polygonal figure.
2. Of an undeterminate figure.

B. Indurated bole.

A. Of no visible particles.

This occurs very often in form of slate, or layers, in the earth ; and then is made use of as an iron ore. However, it has usually been considered more in regard to its texture than to its constituent parts ; and has been called *slate*, in common with several other earths which are found to have the same texture.

a. Reddish-brown ; in most collieries, between the seams of coal.

b. Grey.

B. Of scaly particles.—The *hornblende* of the Swedes.

Argillaceous Earths.

It is diftinguifhed from the martial glimmer, or mica, by the fcales being lefs fhining, thicker, and rectangular.

a. Black.—This, when rubbed fine, gives a green powder.

b. Greenifh.

V. Zeolyte.

This is defcribed in its indurated ftate in the Tranfactions of the academy of fciences at Stockholm for the year 1756, and there arranged as a ftone *fui generis* in regard to the following qualities.

1. It is a little harder than the fluors and the other calcareous fpars; it receives, however, fcratches from the fteel, but does not ftrike fire with it.
2. It melts eafily by itfelf in the fire, with a like ebullition as borax does, into a white frothy flag, which cannot without great difficulty be brought to a folidity and tranfparency.
3. It is more eafily diffolved in the fire by the mineral alkali (*fal fodæ*), than by borax or the microcofmic falt.
4. It does not ferment with this laft falt, as lime does; nor with the borax, as thofe of the gypfeous kind,
5. It diffolves very flowly, and without any effervefcence, in acids, as in oil of vitriol and fpirit of nitre. If concentrated oil of vitriol be poured on pounded zeolites, a heat arifes, and the powder unites into a mafs.
6. In the very moment of fufion it gives a phofphoric light.

There have lately been difcovered fome of the zeolites, particularly at Adelfors's gold mines in Smoland, in Sweden; of which fome forts do not melt by themfelves in the fire, but diffolve readily in the acid of nitre, and are turned by it into a firm jelly.

The zeolyte is found in an indurated ftate:

(1.) Solid, or of no vifible particles.

A. Pure.

a. White.

B. Mixed with filver and iron.

a. Blue, *Lapis lazuli*.

(2.) Sparry zeolite. This refembles a calcareous fpar, though it is of a more irregular figure, and is more brittle.

a. Light red, or orange-coloured.

(3.) Cryftallifed zeolite. This is more common than the two preceding kinds; and is found,

A. In groupes of cryftals, in form of balls, and with concentrical points.

a Yellow.

b White.

B. Prifmatical and truncated cryftals.

a White.

C. Capillary cryftals, which are partly united in groupes, and partly feparate. In this latter accretion they refemble the capillary or feathery filver ore; and are perhaps fometimes called *flos ferri*, at places where the nature of that kind of ftone is not yet fully known.

a. White.

VI. Tripoli.

This is known by its quality of rubbing or wearing hard bodies, and making their furfaces to fhine; the particles of the tripoli being fo fine as to leave even no fcratches on the furface. This effect, which is called *polifhing*, may likewife be effected by other fine clays when they have been burnt a little. The tripoli grows fomewhat harder in the fire, and is very refractory: it is with difficulty diffolved by borax, and ftill with greater difficulty by the microcofmic falt. It becomes white when it is heated: when crude, it imbibes water, but is not diffufible in it: it taftes like common chalk, and is rough or fandy between the teeth, although no fand can by any means be feparated from it. It has no quality common with any other kind of earth, by which it might be confidered as a variety of any other. That which is here defcribed is of a yellow colour, and is fold by druggifts. This kind of tripoli has been lately difcovered in Scotland. But the *rotten-ftone*, fo called, is another fort found in England, viz. in Derbyfhire. It is in common ufe in England among workmen for all forts of finer grinding and polifhing, and is alfo fometimes ufed by lapidaries for cutting of ftones, &c.

The tripoli is found,

1. Solid: of a rough texture.

a. Brown.

b. Yellowifh.

c. Spotted like marble.

2. Friable and compact.

a. Granulated.

b. Brown.

c. Yellowifh.

VII. Common clay, or brick clay.

This kind may be diftinguifhed from the other clays by the following qualities:

1. In the fire it acquires a red colour, more or lefs deep.
2. It melts pretty eafily into a greenifh glafs.
3. It contains a fmall quantity of iron and of the vitriolic acid, by which the preceding effects are produced.

It is found,

A. Diffufible in water.

1. Pure.

a. Red clay.

b. Flefh-coloured, or pale-red.

c. Grey.

d. Blue.

e. White.

f. Fermenting clay.

2. Mixed with lime. See Marle, above.

B. Indurated.

1. Pure.

a. Grey flaty.

b. Red flaty.

2. Mixed with phlogifton, and a great deal of the vitriolic acid. See *Alum Ores*, above.

3. Mixed with lime See Lime, above.

VIII. Argillaceous fiffile ftones.

Thefe and many other different kinds of earth have been comprehended under the denomination of

Argillaceous Earths.

of *ſchiſti*; but to avoid ambiguity we will confine this name to ſtones of the argillaceous kind.

1. The bluiſh purple ſchiſtus, or common roof ſlate; *ſchiſtus tegularis*.

Its colour varies to the pale, to the ſlightly purple, and to the bluiſh.

a. The dark-blue ſlate, *ſchiſtus ſcriptorius*.

2. The pyritaceous ſchiſtus.

This is of a grey colour, brown, blue, or black.

3. The bituminous ſchiſtus.

This is generally black, of a lamellar texture, and of different degrees of hardneſs.

4. Flag ſtone.

This is of a grey, yellowiſh, or reddiſh white colour.

5. The argillaceous grit.

This is called alſo *ſand ſtone* and *free ſtone*, becauſe it may be cut eaſily in all directions.

6. *Killas*.

This ſtone is of a pale grey or greeniſh colour; either lamellar, or coarſely granular. It is found chiefly in Cornwall.

7. *Toadſtone*.

Dr Withering, who has given an analyſis of this ſtone, deſcribes it as being of a dark browniſh grey colour, of a granular texture, not giving fire with ſteel, nor effervefcing with acids. It has cavities filled with cryſtalliſed ſpar, and is fuſible *per ſe* in a ſtrong heat. It is found in Derbyſhire. See Toadstone.

For the œconomical uſes of the argillaceous earths, ſee the article Clay.

[The compounds of this and other earths will fall to be mentioned under a ſubſequent diviſion.]

Class II. SALTS.

By this name thoſe mineral bodies are called which can be diſſolved in water, and give it a taſte; and which have the power, at leaſt when they are mixed with one another, to form new bodies of a ſolid and angular ſhape, when the water in which they are diſſolved is diminiſhed to a leſs quantity than is required to keep them in ſolution; which quality is called *cryſtalliſation*.

In regard to the principal known circumſtances or qualities of the mineral ſalts, they are divided into

1. Acid ſalts, or mineral acids.
2. Alkaline ſalts, or mineral alkalies.

Acid Salts.

Order I. Acid Salts.

For the characters, properties, and phenomena of theſe, ſee the article Acid, and Chemistry-*Index*.

Till of late no more mineral acids were known than the vitriolic and marine; the boracic or ſedative ſalt being reckoned as produced artificially: but later diſcoveries have proved that we may reckon at leaſt *eleven mineral acids;* out of which only two or three have been found in an uncombined ſtate. Thoſe hitherto known are the following, viz. the *vitriolic*, the *nitrous*, the *marine*, the *ſparry*, the *arſenical*, the *molybdenic*, the *tungſtenic*, the *phoſphoric*, the *boracic*, the *ſuccinous*, and the *aerial*. See the article Acid, and Chemistry-*Index*.

I. The vitriolic acid. See Chemistry-*Index*.

II. Nitrous acid.

This acid is by ſome excluded from the mineral kingdom, becauſe they ſuppoſe it to be produced from putrefaction of organic bodies. But theſe bodies, when deprived of life, are again received amongſt foſſils, from whence their more fixed parts were originally derived. For the nature of this acid, ſee Chemistry-*Index*.

III. Acid of common or ſea-ſalt. See Chemistry-*Index*, at *Acid* and *Marine*.

IV. The *fluor* acid, or ſparry fluor acid. See Chemistry-*Index*.

This acid is obtained by art, as it has never been found diſengaged, but united, to calcareous earth, forming a ſparry fluor *, called *Derbyſhire fluor*, *Corniſh fluor*, *blue John*, or *amethyſt root*, when of a purple colour. See p. 72. col. 2. concerning the ſubſtances ariſing from the combination of this acid with calcareous earth.

* See Fluor Spar

V. The acid of *arſenic*. See Chemistry-*Index*.

VI. The acid of *molybdena*. *Ibid*.

VII. The acid of *tungſten*. *Ibid*.

VIII. The *phoſphoric* acid. *Ibid*.

IX. The *boracic* acid. *Ibid*.

X. The ſuccinous or *amber* acid. *Ibid*.

XI. Aerial acid, or *fixed air*. *Ibid*.

Order II. Alkaline Mineral Salts.

For the characters, properties, and phenomea of theſe, ſee the article Alkali; alſo Chemistry-*Index*, at *Alkali* and *Alkalies*.

New acids are daily detected; but no additions have been made to the three ſpecies of alkali long ſince known.

These alkaline ſalts are,

I. Vegetable fixed alkali (a.)

M Vegetable

(a) With regard to the origin of the vegetable fixed alkali, there are ſufficient proofs that it exiſts already formed in plants, and alſo that a portion is formed by combuſtion: but in each caſe, the alkali is obtained in an impure ſtate through the admixture of other matters, which muſt be ſeparated before it can be uſed for chemical purpoſes.

The *cendres gravelées* are made by burning the huſks of grapes and wine lees. They contain the pureſt alkali met with in common, and are uſed by the dyers.

Pot-aſh is made by burning wood and other vegetables. This alkali is much phlogiſticated, and contains many foreign and ſaline matters, which, however, may be ſeparated.

That which is obtained from the aſhes of wood burned in kitchens is the moſt pure of all. On the contrary,

Alkaline Salts.

Vegetable fixed alkali, deprived of every acid, is not found any where by itfelf; but it is fometimes met with in combination with the vitriolic acid or the muriatic, generally with the nitrous, rarely with the aerial (B.)

The fixed vegetable alkali (or *potaffe* of Morveau), is of a powdery appearance, and of a dead white colour. When pure, it is much more cauftic than the neutral falt; it forms with the aerial acid, and even corrodes the fkin (C.)

1. It changes the blue colours of vegetables into a deep green.
2. It has no fmell when dry; but when wetted, it has a flight lixivious odour.
3. Its tafte is ftrongly acrid, burning, cauftic, and urinous (D). This laft fenfation arifes from the volatile alkali it difengages from animal fubftances.
4. When expofed to the air, it attracts humidity, and is reduced into a tranfparent colourlefs liquor. According to Gellert, it attracts three times its own weight of water.
5. It likewife attracts fometimes the aerial acid from the atmofphere, and is thereby deprived of its property of deliquefcing.
6. When it is diffolved in an equal weight of water, it has an oily feel, owing to its action on the fatty parts of the fkin, whence it is, though improperly, called *oil of tartar*.
7. In a moderate heat it melts; but in a more violent fire, it is difperfed or volatilized.
8. It is a moft powerful folvent by the dry way: in a proper heat, it diffolves calcareous, argillaceous, filiceous, and metallic earths: and when the alkali is nearly equal in quantity to the earth, it forms various kinds of hard, folid, and tranfparent glafs.
9. But if the alkali be in quantity three or four times that of the earth, the glafs is deliquefcent.
10. The mild vegetable alkali unites with the vitriolic acid with a violent effervefcence, and produces vitriolated tartar.
11. With the nitrous acid, it forms the cryftallifable falt, called *nitre*.
12. With the marine acid it forms a kind of falt lefs grateful than common falt, which is called the *febrifuge falt of Sylvius*.
13. With vinegar it forms a neutral deliquefcent falt of a fharp tafte, called *terra foliata tartari*.
14. With cream of tartar it forms tartarized tartar.
15. It diffolves fulphur, and forms the fubftance called *liver of fulphur*, which is a powerful folvent of metallic fubftances.
16. It attracts the metals, and diffolves fome of them with peculiar management. Silver, mercury, and lead, are more difficultly diffolved than gold, platina, tin, copper, and efpecially iron. The laft gives a fine reddifh faffron colour, firft obferved by Stahl, who called it the *martial alkaline tincture*.
17. It diffolves in the dry way all the dephlogifticated metallic calces.
18. It unites with oils and other fat fubftances, with which it forms foap.
19. This alkali becomes opaque when expofed to the flame of the blow-pipe: it decrepitates a long time, and forms a glaffy button, which is permanent in the little fpoon; but is abforbed with fome noife on the charcoal when blown upon it.

II. Foffile fixed alkalis.

A. Alkali of the fea, or of common falt (E.)

1. Pure.

This has nearly the fame qualities with the lixivious falt, which is prepared from the afhes of burnt vegetables. It is the fame with the *fal fodæ*, or kelp: for the kelp is nothing elfe than the afhes remaining, after the burning of certain herbs that abound in common falt; but which common falt, during the burning of thofe vegetables, has loft its acid (F).

The properties of the foffile alkali are as follows:

1. It

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trary, that which is got from tartar, properly burned, then diffolved in boiling water, and purified by filtration and cryftallifation, is called *falt of water*. It is the beft.

(B) The vegetable alkali is feldom found in the earth, except in wells of towns, as at Doway, or in the argillaceous alum-ore of la Tolfa: it is found alfo united to the nitrous acid, near the furface of the earth, in Spain and in the Eaft-Indies, probably from the putrefaction of vegetables.

(C) Common vegetable alkali, falt of tartar, and pot-afh, were formerly confidered by chemifts as fimple alkalis; but Dr Black has demonftrated them to be true neutral falts, arifing from the combination of the vegetable alkali with the aerial acid. From hence it follows, that the above common alkalies, even after any other extraneous fubftance has been extracted, muft be freed from this acid, by putting each in a crucible, and expofing it to a ftrong fire, which will diffipate this aerial acid. The alkali fo purified, is to be put in a glafs vial before it be entirely cold, and kept clofe with a proper ftopple; otherwife the aerial acid which floats in large quantities on the atmofphere will combine again with the pure alkali. (*Mongez.*)

(D) The alkali muft be largely diluted with water, in order to be tafted; otherwife it will act on the tongue, and corrode the parts where it touches. (*Macquer.*)

(E) This falt is not met with pure in Europe; but it is faid to be found in both the Indies, not only in great quantity, but likewife of a tolerable purity: it is there collected in form of an efflorefcence in the extenfive deferts, a profitable trade being carried on in it for the making of foap and glafs; and, therefore, it is very probable that the ancients meant this falt by their *natron* or *baurach*. (*Magellan.*)

(F) The mineral alkali is often combined with the vitriolic and marine acid, and alfo with the aerial acid;

Alkaline Salts.

1. It effervesces with acids, and unites with them.
2. Turns the syrup of violets to a green colour.
3. Precipitates sublimate mercury in an orange-coloured powder.
4. Unites with fat substances, and forms soap.
5. Dissolves the siliceous earth in the fire, and makes glass with it, &c. It distinguishes itself from the salt of the pot-ashes by the following properties (G).
6. It shoots easily into rhomboidal crystals; which
7. Fall to powder in the air, merely by the loss of their humidity (H).
8. Mixed with the vitriolic acid, it makes the *sal mirabile Glauberi*.
9. It melts more easily, and is fitter for producing the *sal commune regeneratum, nitrum cubicum*, &c. Perhaps it is also more conveniently applied in the preparation of several medicines.

8

10. It is somewhat volatile in the fire.

III. Volatile mineral alkali.

This perfectly resembles that salt which is extracted from animals and vegetables, under the name of *alkali volatile*, or *sal urinosum*, and is commonly considered as not belonging to the mineral kingdom; but since it is discovered, not only in most part of the clays, but likewise in the sublimations at Solfatara, near Naples, it cannot possibly be quite excluded from the mineral king-kingdom (I).

Its principal qualities are,

a. In the fire it rises in *forma sicca*, and volatilises in the air in form of corrosive vapours, which are offensive to the eyes and nose (K).

b. It precipitates the solution of the mercurial sublimate in a white powder.

c. It also precipitates gold out of aqua-regia, and detonates with it; because,

d. It has a re-action in regard to the acids, tho' not so strongly as other alkalies.

M 2 *e*. It

acid; with which last it retains not only the name but many of the properties of a pure alkali, because this last acid is easily expelled.

It is easily known by its crystallisation and its solubility in two times and an half of its weight of water, at the temperature of 60 degrees.

One hundred parts of this alkali, when pure and recently crystallised, contain 20 of mere alkali, 16 of aerial acid, and 64 of water. (*Macquer*.)

Mineral alkali is found in Hungary, in marshy grounds, of an argillaceous or marly nature, either mixed with water or crystallised and efflorescing. It is found also in Egypt at the bottom of lakes, and dried up by the summer's heat; and also in the province of Suchena, 28 days journey from Tripoli, where it has the name of *Trona*; in Syria, Persia, as well as in the East-Indies, and China, where it is called *kien*. It sometimes germinates on walls, and is called by many *aphronitron*. In its native state, is frequently mixed with magnesian earth, common salt, muriatic magnesia, and marine selenite. (*Kirwan*.)

(G) This mineral alkali likewise differs from the vegetable, 1. By its taste, which is less corrosive and burning. 2. By its not deliquescing. 3. By the small degree of heat it produces if calcined, and afterwards added to water. 4. By its property of crystallising, by evaporating the water from its solution, as is practised with neutral salts; whereas the vegetable alkali does not crystallise unless combined with a large portion of aerial acid.

(H) This alkali being a very useful commodity, and essentially necessary in a number of manufactories, many ingenious processes have been contrived and attempted to procure it at a cheap rate, by decomposing the sea-salt; but it is believed, that till lately none of these new manufactures have succeeded, except that of Mr Turner, mentioned by Mr Kirwan in the second part of the Philosophical Transactions for 1782.—The process is said to consist in mixing a quantity of litharge with half its weight of common salt, which, on being triturated with water till it assumes a white colour, is left to stand some hours; after which, a decomposition ensues, the alkali being left alone, whilst the acid unites to the metallic calx; and this last being urged by a proper degree of fire, produces a fine pigment of a greenish yellow colour, whose sale pays for the most part of the expences.

Mr Kirwan says, in the place already quoted, that if common salt perfectly dry be projected on lead heated to incandescence, the common salt will be decomposed, and a horn-lead formed, according to Margraaf. He adds also, that according to Scheele, if a solution of common salt be digested with litharge, the common salt will be decomposed, and a caustic alkali produced; and, finally, that Mr Scheele decomposed common salt, by letting its solution slowly pass through a funnel filled with litharge.

(I) It is easily known by its smell, though in a mild state, by its volatility, and by its action on copper; the solutions of which, in the mineral acids, are turned blue by an addition of this alkali. It is frequently found, though in small quantities, in mould, marl, clay, schistus, and in some mineral waters. It probably derives its origin, in the mineral kingdom, from the putrefaction or combustion of animal or vegetable substances. (*Kirwan*.)

The same is caustic when uncombined with any acid, not excepting even the aerial acid. It differs from the other two alkalies in many essential particulars. 1. By its aeriform or gaseous nature. For the volatile alkali, in a state of purity, is nothing more than an alkaline gas diffused in water, as Dr Priestley has demonstrated. 2. By its volatility. 3. By the nature of the salts it forms with acids, which are very different from those whose bases are formed either of the vegetable or mineral alkali. (*Mongez*.)

(K) Pure volatile alkali, in an aerial form, resembles atmospheric air, but is more heavy. Its smell is pene-

Neutral Salts.

e. It tinges the solution of copper blue, and dissolves this metal afresh if a great quantity is added (L).

f. It deflagrates with nitre, which proves that it contains a phlogiston.

It is never found pure.

Order III. Neutral Salts.

Acids united to alkalies form neutral salts. These dissolved in water are no ways disturbed by the addition of an alkali; and generally, by evaporation, concrete into crystals. If, by proper tests, they show neither acid nor alkaline properties, they are said to be *perfect* nautrals; but *imperfect*, when, from defect in quantity or strength of one ingredient, the peculiar properties of the other more or less prevail.

I. Vitriolated tartar, vitriolated vegetable alkali, or (as Morveau calls it) the *vitriol of pot-ash*.

This is a perfectly neutral salt, which results from the combination of the vitriolic acid with the vegetable fixed alkali. According to Bergman, it seldom occurs spontaneously in nature, unless where tracks of wood have been burnt down; and Mr Bowles, quoted by Mr Kirwan, says it is contained in some earths in Spain. See Chemistry-*Index*.

It is easily obtained, by pouring the vitriolic acid on a solution of fixed vegetable alkali till it is saturated. Crystals of this neutral salt are then formed. This crystallisation succeeds better by evaporation than by cooling, according to Mongez.

The taste of this salt is disagreeable, though somewhat resembling common salt.

II. Common nitre, (*Alkali vegetabile nitratum*).

This is known in commerce by the name of *salt-petre*, and is also called *prismatic nitre*, to distinguish it from the cubic nitre after-mentioned.—It is perfect neutral salt; resulting from the combination of the nitrous acid with the pure vegetable alkali.

According to Bergman, it is formed upon the surface of the earth, where vegetables, especially when mixed with animal-substances, putrify.—See Chemistry-*Index*, at *Nitre*.

III. Digestive salt, salt of Sylvius, (*Alkali vegetabile salitum*).

This neutral salt is sometimes, though rarely, met with on the earth, generated perhaps, as professor Bergman observes, by the destruction of animal and vegetable substances.

According to Macquer, this salt has been very wrongly called *regenerated marine salt*; and the epithet of *febrifuge* has also been given to it, without any good reason, to evince that it has such a property. But M. de Morveau calls it *muriate de potasse* with great propriety.

This salt is produced by a perfect combination of the vegetable alkali with marine acid. It has been wrongly confounded with common salt.—It is found in some bogs in Picardy, and in some mineral waters at Normandy, according to Monet, quoted by Kirwan. Mongez adds also the sea-water, as containing this salt, and that it is never found in large quantities, although its components parts are abundantly produced by nature. See Chemistry-*Index*, at *Digestive*.

IV. Mild vegetable alkali, (*alkali vegetabile aeratum.*)

This salt was formerly considered as a pure alkali, known by the name of *potash* and *salt of tartar*: but since the discovery of the aerial acid, it is very properly classed among the neutral salts, and ought to be called *aerated potasse*.

It results from a combination of the vegetable alkali with the aerial acid, and is hardly ever found native, unless in the neighbourhood of woods destroyed by fire.

On being exposed on a piece of charcoal, urged by the blow-pipe, it melts, and is absorbed by the coal; but,

In the metallic spoon, it forms a glassy bead, which becomes opaque when cold.

V. Vitriolated acid saturated with mineral alkali; Glauber's salt. *Alkali minerale vitriolatum*.

This is a neutral salt, prepared by nature (as well as by art), containing more or less of iron, or of a calcareous earth; from which arises also some difference in its effects when internally used. It shoots easily into prismatical crystals, which become larger in proportion to the quantity of water evaporated before the chrystallisation. When laid on a piece of burning charcoal, or else burnt with a phlogiston, the vitriolic acid discovers itself by the smell resembling the hepar sulphuris.

It is found in a dissolved state in springs and wells. Some of the lakes in Siberia and Astra-

7 can,

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penetrating, and suffocates animals. Its taste is acrid and caustic. It quickly converts blue vegetable colours to green, and produces heat during its combination with water. But if the water be frozen, it melts, producing at the same time an extreme degree of cold. It has a remarkable action on most metals, particularly copper.

This substance is obtained by the putrefactive fermentation from animal and some vegetable matters. It is this salt which causes that strong smell which is perceived in drains and privies on a change of weather. (*Mongez.*)

Its volatility arises from a very subtile and volatile (or phlogistic) oil, which enters as a principle into its composition. (*Macquer.*)

(L) The solution of copper by this alkali, which is of a fine blue, presents a remarkable phenomenon. For if it be kept in a well closed phial, the colour decays, and at length disappears, giving place to transparency. But on opening the phial, the surface or part in contact with the air becomes blue, and the colour is communicated through the whole mass. This experiment may be many times repeated with the same success.

can, and many springs in other places, contain this salt, according to Bergman. It is found in the sea-water; also in the earth, at several parts of Dauphiné in France, and in Lorraine; and sometimes it germinates on the surface of the earth, according to Monet, quoted by Kirwan. It is found, in a dry form, on walls, in such places where aphronitrum has effloresced through them, and the vitriolic acid has happened to be present; for instance, where marcasites are roasted in the open air. This salt is often confounded with the aphronitum or mild mineral alkali.

VI. Cubic or quadrangular nitre. *Alkali minerale nitratum.*

This is the neutral salt which results from the combination of mineral alkali with nitrous acid. It has almost all the characters of prismatic or common nitre, from which it only differs on account of its base; and takes its denomination from the figure of its crystals, which appear cubic.

This salt rarely occurs but where marine plants putrify. According to Bowles, quoted by Kirwan, it is found native in Spain. See CHEMISTRY, n° 741, &c.

VII. Common salt, or sea-salt; *Alkali minerale salitum, sal commune.*

This salt shoots into cubical crystals during the very evaporation; crackles in the fire, and attracts the humidity of the air. It is a perfectly neutral salt, composed of marine acid, saturated with mineral alkali. It has a saline but agreeable flavour. See CHEMISTRY-*Index*, at *Sea-salt*.

A. Rock salt, fossile salt; *Sal montanum.* Occurs in the form of solid strata in the earth.

1. With scaly and irregular particles.
   - *a.* Grey, and
   - *b.* White. These are the most common, but the following are scarcer:
   - *c.* Red;
   - *d.* Blue; and
   - *e.* Yellow, from Cracow in Poland, England, Salzberg, and Tirol.
2. Crystallised rock salt; *sal gemmæ.*
   - *a.* Transparent, from Cracow in Poland, and from Transylvania.

B. Sea-salt.

This is produced also from sea-water, or from the water of salt lakes by evaporation in the sun, or by boiling.

The seas contain this salt, though more or less in different parts. In Siberia and Tartary there are lakes that contain great quantities of it.

C. Spring sea-salt.

This is produced by boiling the water of the fountains near Halle in Germany, and other places.

Near the city of Lidkoping, in the province of Westergotland, and in the province of Dal, salt-springs are found, but they contain very little salt: and such weak water is called *solen* by the Swedes.

VIII. Borax.

This is a peculiar alkaline salt, which is supposed to belong to the mineral kingdom, and cannot be otherwise described, than that it is . . . . . . dissoluble in water, and vitrescible; . . . . . . that it is fixed in the fire; and melts to a glass; which glass is afterwards dissoluble in water. See the detached article BORAX.

IX. Mild mineral alkali; *Alkali minerale aeratum.* Natron, the nitre of the ancients.

This neutral salt is a combination of the mineral alkali with the aerial acid or fixed air. It is found plentifully in many places, particularly in Africa and Asia, either concreted into crystallised strata, or fallen to a powder; or efflorescing on old brick walls; or lastly, dissolved in springs. It frequently originates from decomposed common salt.

This is an imperfect neutral salt, and was formerly considered as a pure alkali; but the discovery of the aerial acid has shown the mistake.

1. It has nearly all the properties of the *pure* mineral *alkali* N° II. *A.* 1. (p. 90.), but with less energy.
2. The vegetable blue colours are turned green by this salt; it effloresces with acids, and has an urinous taste.
3. It is soluble in twice its weight of cold wa-water; but if the water is hot, an equal weight is sufficient for its solution.
4. It effloresces when exposed to the action of the atmosphere.
5. It fuses easily on the fire, but without being decomposed.
6. Facilitates the fusion of vitrifiable earths, and produces glass more or less fine according to their qualities.
7. It is decomposable by lime and ponderous earth, which attract the aerial acid.
8. And also by the mineral acids; but these expel the aerial acid of this salt, by seizing its alkaline basis, (*Mongez.*)

Wallerius confounds this salt with the *aphronitrum* after-mentioned, and calls it *halinitrum*, when it contains some phlogiston. Mr Kulbel, quoted by Wallerius, showed that it exists in some vegetable earths, and takes it to be the cause of their fertility; but this (M. Magellan observes) can only be on account of its combination with the oily parts of them, and forming a kind of soap, which is miscible with the watery juices.

X. Vitriolic ammoniac, (*Alkali volatile vitriolatum.*)

This neutral salt was called *secret salt of Glauber*, and is a combination of the volatile alkali with vitriolic acid. According to Bergman, it is scarcely found any where but in places where the phlogisticated fumes of vitriolic acid arise from burning sulphur, and are absorbed in putrid places by the volatile alkali. Thus at Fahlun the acid vapour from the roasted minerals produces this salt in the necessary-houses. Dr Withering, however, observes, that as volatile alkali may be obtained in large quantities from pit-coal, and produced by processes not dependent upon putrefaction, there is reason to believe that the vitriolic ammoniac may be formed in several ways not noticed by the above author.

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It is faid to have been found in the neighbourhood of volcanoes, particularly of Mount Vefuvius, where, indeed, it might well be expected; yet its exiftence feems dubious, fince Mr Bergman could fcarce find any trace of it among the various fpecimens of falts from Vefuvius which he examined. The reafon (according to M. Magellan) probably is, that the vitriolic acid difengaged by the combuftion of fulphur is in a phlogifticated ftate; and all its combinations in this ftate are eafily decompofed by the marine acid, which plentifully occurs in volcanoes. It is alfo faid to be found in the mineral lakes of Tufcany, which is much more probable, as the vitriolic acid when united to water eafily parts with phlogifton, and recovers its fuperiority over other acids. It is faid likewife that this neutral falt is found on the furface of the earth in the neighbourhood of Turin.

1. This falt is of a friable texture, and has an acrid and urinous tafte.
2. Attracts the moifture of the atmofphere.
3. Is very foluble in water, it requiring only twice its weight of cold water, or an equal weight of boiling water, to be diffolved.
4. It becomes liquid on a moderate fire; but if urged,
5. It becomes red hot, and volatilizes.
6. The nitrous and muriatic acid decompofe this falt by feizing the volatile alkali. But
7. Lime, ponderous earth, and pure fixed alkali, fet the volatile alkali free, and combine with the vitriolic acid.
8. According to Kirwan, 100 parts of this falt contain about 42 of real vitriolic acid, 40 of volatile alkali, and 18 of water.

This vitriolic ammoniac is eafily known; for if quicklime or fixed alkali be thrown into its folution, the fmell of the volatil alkali is perceived; and if this folution be poured into that of chalk or ponderous earth by the nitrous acid, a precipitate will appear.

XI. Nitrous ammoniac, (*Alkali volatile nitratum.*)

This is a neutral falt, which refults from the combination of the nitrous acid with the volatile alkali. It is frequently found in the mother-liquor of nitre. When mixed with a fixed alkali, the volatile betrays itfelf by its fmell.

1. It is of a friable texture, of a fharp bitter, and of a nitrous or cooling tafte.
2. According to Mongez, it attracts the moifture of the atmofphere; but Romé de l'Ifle afferts, that its cryftals are not deliquefcent: the experiment may be eafily tried, and the truth afcertained.
3. It is foluble in cold water; but half the quantity of water, if boiling, is fufficient for diffolving it.
4. It liquefies on the fire, and afterwards it becomes dry.
5. It detonates with a yellow flame before it is red hot; and what is peculiar to this falt, it needs not, like common nitre, the contact of any combuftible matter for its detonation; from whence it appears that the volatile alkali itfelf poffefs a great fhare of phlogifton.
6. Its component parts, viz. the nitrous acid and the volatile alkali, are not very intimately united; and of courfe,
7. It is eafily decompofed by all the fubftances that have any affinity to either of them.
8. Mixed with the muriatic acid it makes aqua regia.
9. One hundred parts of this neutral falt contain 46 of nitrous acid, 40 of volatile alkali, and 14 of water, as Mr Kirwan thinks.

XII. Native fal ammoniac. The muriatic (or marine) acid faturated with a volatile alkali.

This is of a yellowifh colour, and is fublimed from the flaming crevices, or fire-fprings, at Solfatara, near Naples.

XIII. Aerated or mild volatile alkali.

This neutral falt refults from the combination of volatile alkali united to the aerial acid. It was formerly confidered as a pure alkali:—But the difcovery of the aerial acid (or fixed air) has fhown it to be a true neutral falt, though imperfect; as it retains ftill all the properties of an alkali, though in a weaker degree, on account of its combination with the aerial acid, which is itfelf the moft weak of all acids, and of courfe other ftronger acids eafily diflodge it from its bafe, and from various ammonial falts.

1. This imperfect neutral falt has an urinous tafte, and a particular fmell, which is very penetrating, though lefs pungent, than the pure volatile alkali; and in the fame manner it turns the blue vegetable juices green. But,
2. It effervefces with other acids ftronger than the aerial one, which the pure or cauftic volatil alkali does not.
3. It fublimes very eafily with a fmall degree of heat;
4. And diffolves in twice its weight of cold water; but in a leffer quantity, when this laft is boiling hot.
5. It acts on metallic fubftances, chiefly on copper, with which a blue colour is produced.

According to Bergman, this falt was found in a well in London (Phil. Tranf. for 1767), at Frankfort on the Mein, and at Lauchftadt.—Meffrs. Hierne, Henkel, and Brandt, have found alfo this falt in the vegetable earth, in various kinds of argil, and in fome ftony fubftances. Mr Vozel found it alfo in fome of the incruftations at Gottingen; and Mr Malouin in fome acidulous waters of France.

M. Magellan obferves, that the borax and the three aerated alkalis are called *imperfect* neutrals; whilft the other neutral falts have acquired the name of *perfect*, becaufe thefe laft do not exhibit any of the diftinguifhing properties of their component parts. The three aerated alkalis have a very diftinct alkaline character, as they turn blue vegetable juices green, though not of fo vivid a colour as the cauftic alkali

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alkali does; and the borax is capable of receiving almost an equal quantity of its sedative acid, without losing all its alkaline properties.

In general, those neutral salts, consisting of fixed alkalies combined with acids, are more saturated than those composed of volatile alkali called ammoniacal salts, or those called aerated; which last are only composed by the combination of the aerial acid, united to any alkaline or earthy base.

The aerated alkalis are called also by the name of *mild* alkalis, because they possess no longer that sharp corroding quality which they exhibit when deprived of the aerial acid or fixed air; in which case they are termed caustic alkalis.

These aerated alkalis differ also from the caustic ones, not only on account of the mildness of their taste, from which comes their epithet of mild alkalis, but also by their property of crystallising, and by their effervescing with other acids, which expel the aerial one, the weakest of all acids we know.

Order IV. Earthy *Neutral Salts.*

The compounds of earths and acids which possess solubility are decomposed and precipitated by mild, but not by phlogisticated alkalis.

I. Calcareous earth combined with vitriolic acid.—Vitriolated calx; Selenite; Gypsum. See p. 72. col. 1. *supra.*

The gypsum, or plaster, is not only found dissolved in various waters, but also in many places it forms immense strata. It is placed by all mineralogists among the earths, which it greatly resembles; but it rather belongs to the saline substances of the neutral kind, as appears by its constituent parts. When burnt, it generates heat with water, but in a less degree than lime does. Berg. Sciag. § 59.

This salt has a particular taste, neither bitter nor astringent, but earthy, when applied to the tongue; and it is owing to it that some waters, chiefly from pumps and wells, are called hard waters, because they lie heavy on the stomach.

It is unalterable whilst kept in a dry place; but on being exposed to a moist air, it is much altered, and suffers a kind of decomposition.

When exposed to fire so as to lose the water off its crystallisation, it assumes a dead white colour; and it is then what we call plaster of Paris; but if the fire is too strong, it melts and vitrifies, after losing the vitriolic acid with which it is saturated. See Gypsum.

The most famous quarries of gypsum in Europe, are those of Montmartre, near Paris. See *Journal de Physique*; 1780, vol. xvi. p. 289 and 1782, vol. xix. p. 173.

It is found also in the vegetable kingdom.—Mr Model found that the white spots in the root of rhubarb are a selenitical or gypseous earth (*Journal de Phys.* vol. vi. p. 14.)

What is called fossil flour (*farine fossile* in French), generally found in the fissures of rock and gypseous mountains, is very different from the agaricus mineralis p. 71. col. 1. and from the lac lunæ p. 87. col. 1.; as it is a true gypseous earth, already described p. 72. col. 1. which, according to Mongez, is of a white and shining colour, though sometimes it assumes a reddish or blueish colour, on account of some martial mixture.

II. Nitre of lime, (*Calx nitrata.*)

This earthy salt is sometimes found in water, but very sparingly. It is said that the chalk hills in some parts of France become spontaneously impregnated with nitrous acid, which may be washed out, and after a certain time they will become impregnated with it again. It is a combination of the nitrous acid with calcareous earth. (*Berg. Sciagr.*)

1. It is deliquescent; and is soluble in twice its weight of cold water, or in an equal weight of boiling water.
2. Its taste is bitter.
3. Is decomposed by fixed alkalies, which form the cubic and the prismatic nitres.
4. But caustic volatile alkali cannot decompose it.
5. It does not deflagrate in the fire; yet paper moistened with a saturated solution of it crackles in burning.
6. In a strong heat it loses its acid.
7. Its solution does not trouble that of silver in nitrous acid.
8. The vitriolic acid precipitates its basis.
9. As does likewise the acid of sugar.
10. One hundred parts of it contain, when well dried, about 33 of nitrous acid, 32 of calcareous earth, and 35 of water.

It exists in old mortar, and in the mother liquor of nitre; and also in the chalk rocks near Roche Guyon, in France. (*Kirwan.*)

III. Muriatic chalk, or fixed salt ammoniac. *Acidum salis communis terra calcarea saturatum.*

This somewhat deliquesces, or attracts the humidity of the air. It is found in the sea water.

It is with great impropriety that this salt has obtained the name of ammoniac, on account only of its being formed in the chemical laboratories during the decomposition of the ammoniacal salt with lime, in the process for making the caustic volatile alkali. In this case, the muriatic acid unites to the calcareous basis, while this last gives its water to the volatile alkali; which, therefore, comes over in a fluid caustic state: but if chalk is employed instead of lime, the volatile alkali receives the aerial acid instead of water, and comes over in a concrete form. In neither case, the new combination of calcareous earth with muriatic salt has any volatile alkali to deserve the name of ammoniacal salt. (*Macquer.*)

1. This earthy salt has a saline and very disagreeable bitter taste. It is supposed to be the cause of that bitterness and nauseous taste of sea-water.
2. It fuses in the fire, and becomes phosphorescent, after undergoing a strong heat.
3. It becomes hard, so as to strike fire with steel.
4. It is then the phosphorus of Homberg.
5. It is decomposable by ponderous earth and fixed alkalis.

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6. And also by the vitriolic or nitrous acid; which expel the muriatic acid, to unite with the calcareous basis. (*Mongez.*)

7. Its solution renders that of silver in the nitrous acid turbid, at the same time that

8. It makes no change in that of nitrous selenite.

9. It obstinately retains its acid in a red heat.

10. One hundred parts of this earthy salt contain, when well dried, about 42 of marine acid, 38 of calcareous earth, and 20 of water.

11. It is found in mineral waters, and in the salt works at Saltzburg. (*Kirwan.*)

IV. Aerated chalk, (*Calx aerata.*)

Whenever calcareous earth is over saturated with the aerial acid, it becomes a true earthy neutral salt; becomes soluble in water, and has a slight pungent bitter taste. It is commonly found dissolved in waters, in consequence of an excess of the aerial acid. When this greatly abounds, the water is said to be hard (*cruda*). By boiling or by evaporation, it deposits streaks or crusts of calcareous matter.

But when the calcareous earth is only saturated with the aerial acid without excess, it is not easily soluble; it is then the calcareous spar p. 71. col. 2. and is properly referred to the class of earths, p. 71. col. 1.

V. Vitriolated ponderous earth. *Terra ponderosa vitriolata; barytes vitriolata.*

This earthy salt, known by the name of ponderous spar, is a combination of the ponderous earth described in p. 75. col. 1. with the vitriolic acid; and has been already treated of.

The nitrous ponderous earth, according to Bergman, has not yet been found, although it may perhaps exist somewhere, and of course be discovered in nature.

VI. Muriatic barytes, marine baro-selenite. *Barytes salita.*

This earthy salt consists of marine acid united to the ponderous earth. It is said to have been found in some mineral waters in Sweden; and may be known by its easy precipitability with vitriolic acid, and by the great insolubility and weight of this resulting compound, which is the true ponderous spar of the preceding section.

VII. Aerated ponderous earth. *Barytes aerata.*

This earthy neutral salt was found by Dr Withering in a mine at Alstonmore in the county of Cumberland in England. He says that it is very pure, and in a large mass. This substance is a new acquisition to mineralogy, and may be turned to useful purposes in chemistry.

1. It effervesces with acids, and melts with the blow-pipe, though not very readily.

2. In a melting furnace, it gave some signs of fusion; but did not feel caustic when applied to the tongue, nor had it lost its property of effervescing with acids.

3. But the precipitated earth from a saturated solution of it in the marine acid, by the mild vegetable or mineral alkali being burned, and thrown into water, gave it the properties of lime-water, having an acrid taste in a high degree: and a single drop of it added to the solutions of vitriolated salts, as the Glauber's salt, vitriolated tartar, vitriolic ammoniac, alum, Epsom salt, selenite, occasioned immediately a precipitation; from whence it appears to be the nicest test to discover the vitriolic acid. By it the marine acid may also be easily freed from any mixture of vitriolic acid, by means of this calx of ponderous earth. See Chemistry, n° 1049. *et seq.*

VIII. Vitriolated magnesia.

This earthy neutral salt is called by the English *Epsom salt; Sel d'Angleterre* by the French, and also *sel de Sedlitz, de Seydschutz, sel amer, sel cathartique amer*, &c. These various names are given to it, either on account of its properties, it being a very mild purgative; or from the places where it is found, besides many others, as in the waters of Egra, of Creutzbourg, Obernental, Umea, &c. It has also been found native, mixed with common salt and coaly matter, germinating on some free stones in coal mines. See *Kirwan's Mineralogy*, p. 183.

1. It has a very bitter taste.

2. It is soluble in one part and a half of its weight of cold water: but in hot water, a given weight of it dissolves the double of this salt.

3. It effloresces when exposed to a dry atmosphere, and is reduced to a white powder.

4. Exposed to the fire, it loses the water of its crystallisation, and is reduced into a friable mass.

5. This earthy salt is decomposed by fixed and volatile alkalies.

6. Lime-water precipitates the magnesia from its solution, the calcareous earth of lime-water combining itself with the vitriolic acid, and forming a selenite. *N. B.* By this test the vitriolated magnesia is easily distinguished from the vitriolated mineral alkali or Glauber's salt which it resembles.

7. But crude chalk, or aerated calcareous earth, has not such an effect in the same case; which shows how much the efficacy of this substance, viz. the calcareous earth, is diminished merely by its union with the aerial acid.

8. When urged by the flame with the blow-pipe, it froths; and may be melted by being repeatedly urged with that instrument.

9. With borax it effervesces, and also when burned with the microcosmic salt.

10. According to Bergman, 100 weight of this salt contains only 19 parts of pure magnesia, 33 of vitriolic acid: and 48 of water. But

11. According to Kirwan, 100 parts of it contain about 24 of real vitriolic acid, 19 of magnesian earth, and 57 of water.

IX. Nitrated magnesia; nitrous Epsom salt.

This earthy salt is usually found together with nitre. It is a combination of the nitrous acid with the magnesian earth.

1. It has an acrid taste, very bitter.

2. Attracts the moisture from the atmosphere, and deliquesces.

3. Is very soluble in water.

4. Is

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4. Is easily decomposable by fire.
5. The ponderous and calcareous earths decompose it, and also the alkalies.
6. On being urged by the blow-pipe, it swells up with some noise, but does not detonate.
7. If saturated solutions of nitrous selenite and of this salt be mixed, a precipitate will appear; but,
8. Neither vitriolic acid, nor mild magnesia, will occasion any turbidness in its solution.
9. One hundred parts of this salt contain about 36 of real nitrous acid, 27 of magnesian earth, and 37 of water.

It exists in old mortar, and is found also in the mother liquor of nitre. As lime-water decomposes it, M. de Morveau has indicated the use of this process, not only to complete its analysis; but also to separate, in large quantities, and at a very cheap rate, the magnesian from the calcareous earth, as M. Mongez relates upon this subject.

X. Muriatic magnesia. *Magnesia salita.*

This earthy salt is a combination of magnesian earth with the muriatic acid. According to Bergman, it is found in the sea in greater plenty than any other salt except the sea-salt.

1. It has a very bitter taste: and being always mixed in the sea-water, it is the principal cause of its bitterness.
2. It is very deliquescent, and soluble in a small quantity of water.
3. All the alkalies, even the caustic volatile alkali and lime, decompose it by precipitating its basis.
4. The vitriolic, nitrous, and boracic acids expel the muriatic acid from the base of this neutral salt.
5. Its solution does not trouble that of nitrous or marine selenite; but,
6. It causes a cloud in the nitrous solution of silver.
7. The vitriolic acid throws down no visible precipitate from the solution of this neutral salt.
8. It loses its acid in a red heat.

XI. Aerated magnesia.

Common magnesia, with an excess of aerial acid, is a true neutral salt, like the aerated selenite of p. 96. col. 1. and becomes soluble in cold water. Otherwise it is scarce soluble at all; and is then classed among the earths.

This neutral salt is decomposable by fire, by which its water and its acid are expelled; and it may become phosphoric.

When urged by fire, it agglutinates a little: and some pretended that it melts. But it must be in an impure state to vitrify at all.

The three mineral acids, and the alkalies, dissolve this salt with effervescence, by expelling the aerial acid.

XII. Argillaceous earth combined with vitriolic acid. The *alum* kind. See Alum, and Chemistry-*Index*.

a. With a small quantity of clay; native or plumose alum.

It is found on decayed alum ores in very small quantities; and therefore, through ignorance, the alabastrites and selenites, both of which are found among most of the alum slates, are often substituted in its stead, as is also sometimes the asbestus, notwithstanding the great difference there is between the alum and these both in regard to their uses and effects.

b. With a greater quantity of pure clay; white alum ore.

1. Indurated pale-red alum ore, (*Schistus aluminis Romanus.*) It is employed at Lumini, not far from Civita Vecchia in Italy, to make the pale-red alum called *roch alum*. This is, of all alum ores, the most free from iron; and the reddish earth which can be precipitated from it, does not show the least marks of any metallic substance.

c. With a very large quantity of martial clay, which likewise contains an inflammable substance: Common alum ore. This is commonly indurated and slaty, and is therefore generally called *alum-slate*.

It is found,

1. With parallel plates, having a dull surface; from Andrarum in the province of Skone, Hunneberg and Billingen in the province of Westergottland, Rodoen in the province of Jemtland, and the island of Oeland, &c. In England, the great alum works at Whitby in Yorkshire are of this kind.
2. Undulated and wedge-like, with a shining surface. This at the first sight resembles pit-coal; it is found in great abundance in the parish of Nas in Jemtland.

XIII. Argillaceous earth saturated with muriatic acid. *Argilla salita.*

Professor Bergman says, that the combinations of the argillaceous earth with the nitrous, muriatic, and aerial acids, had not yet been found naturally formed as far as he knew. But Dr Withering affirms, that he found the muriatic argil to exist in a considerable quantity, in the Nevil Holt water, when he analysed that mineral water about the year 1777: and he adds, that it is probably contained also in the Ballycastle water in Ireland.

XIV. Argillaceous earth mixed with volatile alkali.

[Although this mixture is by no means a neutral salt, this seems to be the place to treat of it according to the order of saline substances adopted in this article.]

The greatest part of the clays contain a volatile alkali, which discovers itself in the distillation of the spirit of sea-salt. &c.

Order V. Metallic Salts.

The native salts belonging to this division may be distinguished by the phlogisticated alkali, which precipitates them all. The few which have saline properties, according to the definition of salts formerly given, shall be mentioned here; referring the rest to the mineralised metals; as the *luna cornea*, the saline quicksilver or muriatic mercury, &c.

Metallic Neutral Salts.

I. Vitriol of copper; blue vitriol. *Vitriolum veneris, seu cyprium.*

This neutral metallic salt is a combination of the vitriolic acid with copper, and is found in all *ziment waters*, as they are called. Its colour is a deep blue; and being long exposed to the air, it degenerates into a rusty yellow blue. Urged by the flame of the blow-pipe on a piece of charcoal, it froths at first with noise, giving a green flame, and the metallic particles are often reduced to a shining globule of copper, leaving an irregularly figured scoria. But with borax the scoria is dissolved, and forms a green glass.

This salt rarely occurs crystallised: but is often found naturally dissolved in water in Hungary, Sweden, and Ireland: from this water a blue vitriol is generally prepared. These natural waters are called *cementatory* or *cementing* ones. According to Monet, this concrete salt, when found naturally formed, only proceeds from the evaporation of such waters. It is also occasionally extracted from sulphurated copper ores after torrefaction. See Chemistry-*Index*, at *Vitriol.*

II. Muriatic copper, or marine salt of copper. *Cuprum salitum.*

This salt has been found in Saxony, in the mine of Johngeorgenstadt. 1. It is of a greenish colour, and foliated texture. 2. It is moderately hard. 3. Sometimes it is transparent and crystallised.

It has been taken for a kind of mica: but Professor Bergman found it to consist of copper and marine acid, with a little argillaceous earth.

Another specimen of a purer sort was deposited in the museum of Upsal. This is of a bluish green colour, and friable. It effervesced with nitrous acid, to which it gave a green colour: and by adding a proper solution of silver, a *luna cornea* was formed, by which the presence of the muriatic acid was ascertained. (*Kirwan* and *Bergman*)

III. Martial vitriol; vitriol of iron. Common green vitriol or copperas.

This is the common green vitriol, which is naturally found dissolved in water, and is produced in abundance by decayed or calcined marcasites.

This metallic neutral salt results from the combination of the vitriolic acid with iron.

1. It is of a greenish colour when perfectly and recently crystallised; but,
2. Effloresces by being exposed to the air, becomes yellowish, and is covered with a kind of rust. Sometimes it becomes white by long standing.
3. It requires six times its weight of water, in the temperature of 60 degrees, to be dissolved.
4. It has an astringent, harsh, and acidulous taste.
5. Exposed to a moderate heat, even to that of the sunshine, it falls into a yellowish powder: but,
6. On being exposed to a sudden heat, it melts; and on cooling, assumes a whitish brown colour.
7. When strongly urged by fire, it loses its acid, becomes of a dark red colour, and is then called *colcothar;* a powder which is employed in polishing metals, and to which our artists have applied the improper name of *crocus martis*, though this name only belongs to the yellow preparations of the iron-calces, used in pharmacy and in enamelling, &c.
8. Pure fixed alkali precipitates the iron from its solution in deep green flakes; the mild alkali, in a greenish white colour; pure volatile alkali, in so deep a green, that it appears black; but the mild volatile alkali precipitates it in a greyish-green colour.
9. All vegetable astringents, as the tincture of tea, quinquina, gales, &c. precipitate the iron in a black colour: hence they are used as tests to discover its presence in chemical analyses; and it is from this black precipitate that the common writing ink is made, being diluted in water, and there suspended by the Arabic or Senegal gums.
10. One hundred parts of this salt, recently crystallised, contain 20 of real vitriolic acid, 25 of iron, and 55 of water.
11. Its acid is known by this, that its solution mixes without turbidity with the solutions of other salts that contain vitriolic acid; as Epsom, selenite, vitriolated tartar, &c.
12. And the basis of this metallic salt is known by the black colour produced by the solution of vegetable astringents.
13. On being urged by the flame thrown by the blow-pipe, it offers the same phenomena as the vitriol of copper, except that it does not colour the flame.

Green vitriol is frequently found native, either in coal mines or in the cavities of pyritaceous mines, or adhering to their scaffolds in a stalactitical form. It is found also in small round stones, called *ink-stones*, of a white, red, grey, yellow, or black colour, which are almost soluble in water, and contain a portion of copper and zinc. Also sometimes in form of schistus or slaty pyritaceous stones. But the greatest part of that in use is prepared by art, from the martial pyrites or mundic. See Chemistry, n° 619.

IV. Aerated iron. *Ferrum aeratum.*

This metallic salt is a combination of the aerial acid with iron; and is found in the light chalybeate waters, where it is dissolved by an excess of this acid.

Mr Lane was the first who discovered in England the action of the aerial acid on iron, when the water is impregnated with that menstruum. The late M. Rouelle demonstrated the same phenomenon in France upon this and other metals. But Professor Bergman seems to have preceded them both nearly about the same time, though neither had any knowledge of each other's discoveries.

The great volatility of this acid is the cause why this neutral salt is not often found. For the mere evaporation of the ferruginous mineral waters, in order to analyse them, is sufficient to let loose the aerial acid; so that the iron which was there dissolved by its power falls down to the bottom in the form of a light ore, which amounts to nearly $\frac{1}{10000}$ of the weight of the water; and when

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when fresh retains so much phlogiston as to obey the magnet, as Bergman says.

V. Vitriol of cobalt, or vitriolated cobalt.

This metallic salt results from the combination of the vitriolic acid with cobalt.

1. When found native, it is always in an efflorescent state; whence it arises that, in this case,
2. Its colour is greenish, mixed with a grey tint: but,
3. It is of a rosy colour when artificially made;
4. Effloresces when exposed to the action of the atmosphere; and,
5. Takes then a greenish colour mixed with a pale purple, or a *Lilias colour*, as the French call it.
6. It is difficultly soluble in water; and,
7. Its solution is of a red colour.
8. The phlogisticated alkali precipitates the cobalt from the solution of this salt, which with borax gives an azure glass.

By the above qualities, chiefly the rosy colour of the solution of this neutral salt, its basis is sufficiently distinguished. As to its acid, it is easily known by the same tests as those of the preceding vitriols.

It is said to be found native in small pieces, mixed with a greenish efflorescence in cobalt mines. (*Kirwan* and *Mongez*.)

VI. Vitriol of zinc, vitriolated zinc, or white vitriol.

This neutral metallic salt results from the combination of vitriolic acid with zinc.

1. Its colour is white. It,
2. Requires little more than twice its weight of water to dissolve it in the temperature of 60 degrees of Fahrenheit's thermometer, and deposits a greyish yellow powder.
3. Its specific gravity is 2000.
4. Its taste is very styptic.
5. It mixes uniformly with vitriolic neutral salts.
6. Precipitates nitrous or marine selenites from their solutions, by which its acid is ascertained.
7. It is precipitable in a whitish powder by alkalies and earths; but,
8. Neither iron, copper, nor zinc, precipitate it: by which circumstance its basis is sufficiently indicated.
9. If it contains any other metallic principle, this may be precipitated by adding more zinc to the solution; excepting iron, which will of itself precipitate by exposure to the air or boiling in an open vessel.
10. One hundred parts of this metallic salt contain 22 of vitriolic acid, 20 of zinc, and 58 of water.
11. Urged by fire, it loses a good part of its acid.
12. Treated with the blow-pipe, it exhibits nearly the same phenomena as other metallic vitriols; except only that the flame is brilliant when the zinc is reduced, and gives out white flocs called *flowers of zinc*

This neutral metallic salt is sometimes found native, mixed with vitriol of iron, and in the form of white hairy crystals; or in a stalactitical form in the mines of Hungary, or as an efflorescence on ores of zinc. It is also found dissolved in mineral waters, and generally with some proportion of vitriols of iron and copper. Bergman says, it is sometimes produced by the decomposition of pseudogalæna, or black-jack; but this rarely happens, because this substance does not readily decompose spontaneously.

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But that in common use is mostly prepared at Goslaar, from an ore which contains zinc, copper, and lead, mineralised by sulphur and a little iron. The copper is first separated as much as possible: the remainder after torrefaction and distillation is thrown red-hot into water and lixiviated. It is never free from iron. (*Kirwan*, *Mongez*.)

VII. Vitriolated nickel, or vitriol of nickel

This neutral metallic salt results from the combination of the vitriolic acid with nickel. It exists sometimes in consequence of the decomposition of the sulphureous ores of this semimetal. It is found native, efflorescing on Kupfer-nickel; and generally mixed with vitriol of iron.—It is of a green colour, as well as its solution. It is precipitated by zinc; but when joined with iron, this last is not precipitated by the same.

Its origin is perhaps owing to the decomposition of the pyritaceous and sulphureous ore of Kupfer-nickel, mentioned by Wallerius. This ore contains a great quantity of arsenic and sulphur, as well as cobalt, nickel, and iron. And if it comes to be decomposed in the bowels of the earth, it is natural to expect that the vitriolic acid of the sulphur will attack the nickel and the iron, with which it will form neutral metallic salts (*Mongez*, *Kirwan*).

VIII. Muriatic manganese. *Manganesium salitum.*

M. Hielm is the only person who has as yet found this middle salt in some mineral waters of Sweden. It is composed by the combination of the regulus of Manganese with muriatic acid.

1. It is precipitated of a whitish yellow colour, by the Prussian (phlogisticated) alkali; and of a brownish yellow, by the mineral alkali. 2. It does not crystallise in any distinct form. 3. It abstracts the moisture of the air. 4. To obtain its basis free from iron, it must be precipitated by the mineral alkali; redissolved in nitrous acid; then calcined until this acid is expelled; and the residuum is to be treated with distilled vinegar, which will then take up only the manganese. (*Kirwan*.)

Order VI. Triple Salts.

The neutral salts hitherto enumerated are such as are composed of two ingredients only; but sometimes three or more are so united as not to be separated by crystallization. The vitriols that we are acquainted with are hardly ever pure; and two or three of them sometimes are joined together.

Sometimes likewise it happens that neutral salts join earthy salts, and earthy salts metallic ones. Bergman generally distinguishes compound salts according to

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the number of their principles, whether the fame acid be joined to feveral bafes, or the fame bafe to different acids; or, laftly, whether feveral menftrua and feveral bafes are joined together. Hence arife falts triple, quadruple, &c. which the diligence of aftertimes muft illuftrate. The moft remarkable examples of triple and quadruple native falts which have yet occurred are,

I. Mineral alkali, with a fmall quantity of calcareous earth. *Alkali falis communis*. Aphronitrum.

This is fo ftrongly united with the calcareous earth, that the latter enters with it into the very cryftals of the falt: though by repeated folutions the earth is by degrees feparated from it, and falls to the bottom after every folution.

It grows in form of white froft on walls, and under vaults; and in places where it cannot be wafhed away by the rain.

Hence it would appear, that this is not only a *triple*, but a *multiple* falt; as thefe pieces of old mortar covered with this white froft, on ancient walls, are the very fame from which the faltpetre makers extract the mother-water of nitre, after mixing therewith the vegetable afhes, to furnifh the alkaline bafe to it. M. Fourcroy fays in his feventeenth Lecture, that this mother-water contains not only nitre, but five other kinds of falt, viz. the *marine falt*, *nitrous magnefia*, *calcareous nitre*, *magnefia nitrata*, and *calx falita*; to which the chemifts of Dijon add the *digeftive falt of Sylvius*, and in fome cafes various *vitriols* with *alkaline* or *earthy bafes*.

When it contains any confiderable quantity of the calcareous earth, its cryftals become rhomboidal, a figure which the calcareous earth often affumes in fhooting into cryftals: but when it is purer, the cryftals fhoot into a prifmatic figure.

This is a circumftance which neceffarily muft confufe thofe who know the falts only by their figure; and fhows, at the fame time, how little certainty fuch external marks afford in a true diftinction of things.

This falt is very often confounded with the *fal mirabile Glauberi*.

II. Common falt with magnefia; or muriatic mineral alkali contaminated by muriatic magnefia.

This is a compound of the common falt with muriatic magnefia: and by the expreffion *contaminated (inquinatum)* of profeffor Bergman, we may fuppofe that the magnefian falt is not intimately united to the alkaline bafe.

This triple falt is very deliquefcent; a quality it owes to its integrant part the muriatic magnefia, (p. 97. col. 1.) For the pure muriatic alkali does not deliquefce: but this degree of purity is feldom found, even in the native foffil or *fal gem*, (p. 93. col. 2.) In general all the earthy marine falts are very deliquefcent, as the muriatic chalk, the muriatic barytes, and the muriatic magnefia. *Bergman*, *Macquer*, and *Mongez*.

III. Mineral alkali with fuccinous acid and phlogifton.

This fubftance will be afterwards mentioned among the *inflammables*.

IV. Vitriolated magnefia with vitriol of iron. Epfom falt contaminated with copperas.

Found in fome mineral waters, according to Mr Monet, (*Treatife on Mineral Waters*).

V. Native-alum contaminated by copperas. Vitriolated argil with vitriol of iron.

Found in the aluminous fchiftus. It fometimes effloresces in a feathery form. Perhaps this is the *plumofe alum* of the ancients.

VI. Native alum, contaminated by fulphur.

At the places about Wednefbury and Bilfton, in Staffordfhire, where the coal pits are on fire, this fubftance fublimes to the furface; and may be collected, in confiderable quantity, during dry or frofty weather.

A fimilar compound fubftance fublimes at the Solfaterra near Naples.

VII. Native alum contaminated by vitriolated cobalt.

In the mines of Herregrund and Idria this falt may be feen fhooting out into long flender filaments. Perhaps this is the *trichites* of the Greeks.

1. Diffolved in water, it immediately betrays the prefence of vitriolic acid upon the addition of terra poderofa falita (muriatic acid faturated with heavy earth).
2. By the addition of phlogifticated alkali, a precipitate of cobalt is thrown down, which makes blue glafs with borax or microcofmic falt. (*Berg. Sciag.*)

VIII. Vitriol of copper with iron.

This falt is of a bluifh green colour. It is the *vitriolum ferreo-cupreum cyaneum* of Linnæus. Its colour varies, being fometimes more or lefs green, and fometimes more or lefs blue. It is found at Saltzberg and at Falhun. This vitriol is called *vitriol of Hungary*, becaufe it is found in the Hungarian mines is of this kind. (*Mongez.*)

IX. Vitriol of copper, iron, and zinc.

This is the *vitriolum ferreo-zinceo cupreum cyaneum* of Linnæus. Its colour is of a blue inclining to green. If rubbed on a polifhed furface of iron, the copper is not precipitated thereby, as it happens to the blue vitriol; which fhows that the vitriolic acid is perfectly faturated in this falt by the three metallic bafes.

X. Vitriol of copper and zinc.

This is the blue vitriol from Goflar. According to Mongez it is the *vitriolum zinceo-cupreum cæruleum* of Linnæus.

XI. Vitriol of iron and zinc.

This is the green vitriol from Goflar in the Hartz. According to Mongez, this is the *vitriolum zinceo-ferreum viride* of Linnæus, 105. 6. Its colour is a pale-green caft.

XII. Vitriol of iron and nickel.

This falt is of a deep-green colour, and is contained in the ochre, or decayed parts, of the nickel, at the cobalt-mines of Los, in the province of Helfingland.

Class III. Mineral INFLAMMABLE Substances.

To this clafs belong all thofe fubterraneous bodies that are diffoluble in oils, but not in water, which they

repel; that catch flame in the fire; and that are electrical.

It is difficult to determine what conftitutes the difference between the purer forts of this clafs, fince they all muft be tried by fire, in which they all yield the fame product; but thofe which in the fire fhow their differences by containing different fubftances, are here confidered as being mixed with heterogeneous bodies: that fmall quantity of earthy fubftance, which all phlogifta leave behind in the fire, is, however, not attended to.

I. Inflammable air; fire damp.

This aeriform fubftance is eafily known by its property of inflaming when mixed with twice or thrice its bulk of common atmofpheric air; and it is afferted to be the real phlogifton almoft pure. See Aerology-*Index*, and Inflammable *Air*.

It admits confiderable varieties, acording to the nature of the fubftances from which it is produced, and often gives different refiduums upon combuftion, fome of which are of the acid kind. If it is produced from charcoal, it yields aerial acid or fixed air: from folutions of metallic fubftances in the vitriolic, nitrous, or marine acids, it yields thefe refpective acids, as M. Lavoifier afferts.

Æther, converted into vapour in a vacuum, gives a permanent elaftic vapour, which is inflammable. The atmofphere, which floats round the fraxinella, is inflammable from the admixture of its vapours, which feem to be of the nature of an effential oil: fo that on approaching the flame of a candle under this plant, in hot weather, it takes fire in an inftant; although the effential oil, extracted from this plant by diftillation, is not inflammable on account of the watery particles mixed with it, as M. Bomare afferts.

Mr Scheele is of opinion, that every inflammable air is compofed of a very fubtile oil. This coincides with the idea entertained by chemifts of their phlogifton; and is confirmed by the fact, of its being naturally found in thofe fprings from whence iffues petrol, whofe exhalations are very inflammable.

The refiduum, which remains in the atmofphere after the combuftion of inflammable air, is extremely noxious to animals. Doctor Prieftley takes it to be a combination of phlogifton with pure air, and on this account calls it *phlogifticated air*. But M. Lavoifier, on the contrary, confiders it to be a primitive fubftance of an unchangeable nature, and gives it the fingular name of *atmofpheric mephitis*.

II. Hepatic air.

This air feems to confift of fulphur, held in folution in vitriolic or marine air. It is inflammable when mixed with three quarters of its bulk of common air. Nitre will take up about half the bulk of this air; and when faturated with it, will turn filver black: but if ftrong dephlogifticated nitrous acid be dropped into this water, the fulphur will be precipitated.

One hundred cubic inches of this air may hold eight grains of fulphur in folution in the temperature of 60°; and more, if hotter.

Atmofpheric air alfo decompofes hepatic air.

It is found in many mineral waters, and particularly in the hot baths of Aix-la-Chapelle. The caufe and manner of their containing fulphur, which was long a problem, has at laft been happily explained by Mr Bergman.

It plentifully occurs in the neighbourhood of volcanoes and in feveral mines.

Hepatic air is eafily obtained by art, from all forts of liver of fulphur, whether the bafe be an alkali, an earth, or a metal, if any acid is poured upon it; and the better, if ufe be made of the marine acid, becaufe it contains phlogifton enough, and does not fo ftrongly attract that of the *hepar fulphuris*. For this reafon the nitrous acid is not fit for this procefs, as it combines itfelf with the phlogifton, and produces nitrous air. It may alfo be produced, by diftilling a mixture of fulphur and powdered charcoal, or of fulphur and oil, &c. See the detatched article *Hepatic Air*, and Aerology-*Index*.

III. Phlogifton combined with aerial acid; black lead, or wadd. *Plumbago*. See the detached article *Black-Lead*.

It is found,

a. Of a fteel-grained and dull texture. It is naturally black, but when rubbed it gives a dark lead colour.

b. Of a fine fcaly and coarfe-grained texture; coarfe black-lead.

IV. Mineral tallow. *Serum minerale*.

This was found in the fea on the coafts of Finland in the year 1736. Its fpecific gravity is 0.770; whereas that of tallow is 0.969. It burns with a blue flame, and a fmell of greafe, leaving a black vifcid matter, which is with more difficulty confumed.

It is foluble in fpirit of wine only when tartarifed: and even then leaves an infoluble refiduum; but expreffed oils diffolve it when boiling.

It is alfo found in fome rocky parts of Perfia, but feems mixed with petrol, and is there called *fchebennaad, ifienpen, kodreti*.

Dr Herman of Strafburg mentions a fpring in the neighbourhood of that city, which contains a fubftance of this fort diffufed through it, which feparates on ebullition, and may then be collected. (*Kirwan*).

V. Ambergris. *Ambra grifea*.

It is commonly fuppofed to belong to the mineral kingdom, although it is faid to have doubtful marks of its origin (A).

a. It

(A) Ambergris, according to the affertion of M. Aublet (in his *Hiftoire de la Guiane*), is nothing more than the juice of a tree infpiffated by evaporation into a concrete form. This tree grows in Guyana, and is called

Inflammables.

a. It has an agreeable ſmell, chiefly when burnt:
b. Is conſumed in an open fire:
c. Softens in a ſlight degree of warmth, ſo as to ſtick to the teeth like pitch.
d. It is of a black or grey colour; and of a dull or fine grained texture (B).

The grey is reckoned the beſt, and is ſold very dear. This drug is brought to Europe from the Indies. It is employed in medicine; and alſo as a perfume (C).

VI. Amber. *Ambra flava, ſuccinum, electrum,* Lat. *Carabé,* French. *Agtſtein, Bernſtein,* Germ.

This ſubſtance is dug out of the earth, and found on the ſea-coaſts. According to the experiments of M. Bourdelin, it conſiſts of an inflammable ſubſtance, united with the acid of common ſalt, which ſeems to have given it its hardneſs.

It is ſuppoſed to be of vegetable origin, ſince it is ſaid to be found together with wood in the earth.

By diſtillation it yields water, oil, and a volatile acid ſalt, which the above mentioned author has thought to be the acid of common ſalt united with a ſmall portion of phlogiſton.

Inſects, fiſh, and vegetables, are often found included in it, which teſtify its having once been liquid.

It is more tranſparent than moſt of the other bitumens; and is doubtleſs the ſubſtance which firſt gave riſe to *electrical experiments* (on account of the power it poſſeſſes of attracting little bits of ſtraw, or of other light ſubſtances, when rubbed).

Its varieties are reckoned from its colour and tranſparency. It is found,

A.

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called *cuma,* but has not been inveſtigated by other botaniſts. When ſome branches are broken by high winds, a large quantity of the juice comes out; and if it chances to have time to dry, various maſſes (ſome of which had been ſo large as to weigh 1200 pounds and more) are carried into the rivers by heavy rains, and through them into the ſea: afterwards they are either thrown into the ſhore or eaten by ſome fiſh, chiefly the ſpermaceti whale, known by the name of *Phyſeter-macrocephalus* among ichthyologiſts. This kind of whale is very greedy of this gum-reſin, and ſwallows ſuch large quantities when they meet with it, that they generally become ſick; ſo that thoſe employed in the fiſhery of theſe whales, always expect to find ſome amber mixed with the excrements and remains of other food in the bowels of thoſe whales who are lean. Various authors, among whom is Father Santos in his *Ethiopia Orientalis,* who travelled to various places of the African coaſt, and Bomare, ſay, that ſome ſpecies of birds are fond of eating this ſubſtance as well as the whales and other fiſhes. This accounts very well for the claws, beaks, bones, and feathers of birds, parts of vegetables, ſhells, and bones of fiſh, and particularly for the beaks of the cuttle fiſh or *ſepia octopedia,* that are ſometimes found in the maſs of this ſubſtance. Dr Swediar, however, attended only to theſe laſt, though he had mentioned alſo the other ſubſtances in his paper inſerted in the Philoſophical Tranſactions for 1783; wherein he attempts to eſtabliſh an opinion, that the amber is nothing elſe but a preternaturally hardened dung, or feces, of the phyſeter whale. Dr Withering and Mr Kirwan have embraced this notion; as did alſo, inadvertently, the editors of this Work. See AMBERGRIS.

(B) Mr Aublet brought ſpecimens of this gum-reſin, which he collected on the ſpot, from the cuma tree at Guiane. It is of a whitiſh-brown colour with a yellowiſh ſhade, and melts and burns like wax on the fire. The ſingularity of this gum-reſin is, that it imbibes very ſtrongly the ſmell of the aromatic ſubſtances which ſurround it; and it is well known that perfumers avail themſelves very conſiderably of this advantage. M. Rouelle examined very carefully this ſubſtance brought over by Mr Aublet, and found that it produced the very ſame reſults as in other good kind of amber. Beſides Mr Aublet's authority, which is deciſive, as being grounded upon direct proofs of fact, Rumphius, quoted by Bergman, long ſince mentioned a tree called *Nanarium,* whoſe inſpiſſated juice reſembles amber. It cannot therefore at preſent be doubted that the origin of this phlogiſtic ſubſtance is the vegetable kingdom, although it may be often found and reputed as a product of the foſſile kind.

This ſuſtance being analyſed by Meſſrs Geoffroy and Newman, quoted by M. Fourcroy, yielded them the ſame principles as the bitumens; viz. an acid ſpirit, a concrete acid ſalt, ſome oil, and a charry reſiduum; which evidently evinces, that all theſe fat and oily foſſile ſubſtances have their origin from the other two kingdoms of nature.

(C) Ambergris is not only brought from the Eaſt Indies, but from the coaſts of the Bahama Iſlands, Braſil, Madagaſcar, Africa, China, Japan, the Molucca iſlands, the coaſts of Coromandel, Sumatra, &c. Dr Lippert, in a treatiſe he publiſhed at Vienna in 1782, entitled *Phlogiſtologia Mineralis,* has copied chiefly from Wallerius what he aſſerts of this ſubſtance. He affirms that there are eight known ſpecies of amber; five of a ſingle colour, viz. the white and the black from the iſland of Nicobar, in the gulph of Bengal, the aſh-coloured, the yellow, and the blackiſh; and two variegated, viz. the grey coloured with black ſpecks, and the grey with yellow ſpecks. This laſt he aſſerts to be the moſt eſteemed on account of its very fragrant ſmell, and to come from the South coaſt of Africa and Madagaſcar, as well as from Sumatra; and that the black dark coloured amber is often found in the bowels of the cetaceous fiſhes. The ſame author adds alſo from Wallerius, that by diſtilling the oil of yellow amber (*ſuccinum*) with three parts and a half of fuming nitrous acid, a reſiduum remains like roſin, which emits a perfect ſmell of muſk; whence ſome conclude, that the ambergris belongs to the foſſile kind: the contrary, however, is evinced in the preceding note.

Inflammables.

A. Opaque.
a. Brown.
b. White.
c. Blackiſh.
B. Tranſparent.
a. Colourleſs.
b. Yellow.

The greateſt quantity of European amber is found in Pruſſia; but it is, beſides, collected on the ſea-coaſt of the province of Skone, and at Biorko; in the lake Malaren in the province of Upland; as alſo in France and in Siberia. It is chiefly employed in medicine and for making varniſhes (D).

VII. Rock-oil.

This is an inflammable mineral ſubſtance, or a thin bitumen, of a light brown colour, which cannot be decompoſed; but is often rendered impure by heterogeneous admixtures. By length of time it hardens in the open air, and then reſembles a vegetable reſin; in this ſtate it is of a black colour, whether pure or mixed with other bodies. It is found,

A. Liquid.

1. Naphtha.

This is of a very fragrant ſmell, tranſparent, extremely inflammable, and attracts gold. It is collected on the ſurface of the water in ſome wells in Perſia. See NAPHTHA.

2. Petrol.

This ſmells like the oil of amber, though more agreeable; and likewiſe very readily takes fire. It is collected in the ſame manner as the Naphtha from ſome wells in Italy. See PETROLEUM.

B. Thick and pitchy; *Petroleum tenax.* Barbadoes-tar.

This reſembles ſoft pitch.

It is found at the Dead Sea in the Holy Land; in Perſia, in the chinks of rocks, and in ſtrata of gypſum and limeſtone, or floating on water; alſo in Siberia, Germany, and Switzerland, in coal-pits; and in America: likewiſe in Colebrookdale in England.

C. Elaſtic petrol.

This is a very ſingular foſſil, found of late in England.

By its colour and conſiſtency, it exactly reſembles the Indian-rubber, or the gum-reſin, from the north part of Braſil, called *caoutchouc.* It is of a dark brown colour, almoſt black; and ſome is found of a yellowiſh brown caſt, like the ſame gum-reſin.

With reſpect to its elaſtic conſiſtence, it hardly can be diſtinguiſhed from it, except in the coheſion of its particles, which is weaker.

It has the ſame property of rubbing off from paper the traces of black-lead pencils.

It burns likewiſe with a ſmoky flame; and alſo melts into a thick oily fluid; but emits a diſagreeable ſmell, like the foſſile pitch, or Barbadoes tar.

It

(D) Amber, ſays M. Fourcroy, is found in ſmall detached pieces, for the moſt part under coloured ſands, diſperſed in beds of pyritaceous earth; and above it is found wood, charged with a blackiſh bituminous matter. Hence it is ſtrongly ſuppoſed that it is a reſinous ſubſtance, which has been altered by the vitriolic acid of the pyrites, notwithſtanding that we know that acids, when concentrated, always blacken and charry reſinous ſubſtances. In fact, the chemical analyſis of this ſubſtance rather confirms that ſuppoſition.

The ſingular opinion of Dr Girtanner, about the yellow amber being produced by a kind of ants, may be ſeen in *Journal de Phyſique* for March 1786, page 227. Or ſee the article AMBER in this Dictionary.

The colour, texture, tranſparency, and opacity of this ſubſtance, have ſhown ſome other varieties beſides theſe mentioned in the text. The principal ones are the following:

6. The yellow ſuccinum,
7. The coloured green or blue by foreign matter,
8. The veined ſuccinum,
} opaque.

9. The white,
10. The pale-yellow,
11. The citron-yellow,
12. The deep-red,
} tranſparent.

The golden yellow tranſparent amber, mentioned in the text, is what the ancients called *chryſolectrum*, and the white opaque was called *leucolectrum*.

But we muſt be cautious about the value of the ſpecimens remarkable for their colour, ſize, tranſparency, and the well-preſerved inſects they contain internally; ſince there is a probability of deception, ſeveral perſons poſſeſſing the art of rendering it tranſparent and coloured, and of ſoftening it, ſo as to introduce foreign ſubſtances, &c. into it at pleaſure.

M. Fourcroy ſays, that two pieces of this ſubſtance may be united, by applying them to one another, after being wet with oil of tartar and heated. And Wallerius mentions, that pieces of yellow amber may be ſoftened, formed into one, and even diſſolved by means of oil of turnip-ſeed, in a gentle heat; and that according to ſome authors, it may be rendered pure and tranſparent, by boiling it in rape-ſeed oil, linſeed oil, ſalt-water, &c.

Mr Macquer ſays, that for the purpoſe of making varniſh, this ſubſtance muſt undergo beforehand a previous decompoſition by torrefaction, in order to be diſſolved by linſeed-oil or eſſential oils. See VARNISH.

Beſides the making of varniſhes, this ſubſtance was much employed formerly in making various pieces of ornament and jewellery. The beſt pieces were cut, turned, carved, or plained, to make vaſes, heads of canes, collars, bracelets, ſnuff-boxes, beads, and other toys, ſmall fine cheſts, &c. But after diamonds and beautiful hard ſtones were brought into uſe, theſe trinkets are little conſidered in Europe: nevertheleſs, they are ſtill ſent to Perſia, China, and to various other eaſtern nations, who eſteem them ſtill as great curioſities.

Inflammables.

It is found in the fame earthy and ftony beds as petrol. Some fpecimens are of a cylindrical form, like bits of thin branches or ftalks of vegetables, though much more flexible, being perfectly elaftic.

M. Magellan obferves, that this foffil feems to favour the opinion of thofe mineralogifts, "who believe that thefe oily combuftibles derive their origin from the vegetable kingdom. It feems worth trying, whether pieces of afphaltum, buried in damp beds of fparry rubbifh, or other kind of earths, would take the fame elaftic confiftence. But fince many beds of fhells and other foffile fubftances, both of the vegetable and animal kind, as impreffions of various plants, and the remains of various quadrupeds, &c. have been found in different parts of the globe, whofe individual fpecies undoubtedly exift no longer alive unlefs in far diftant climates, and in the moft remote countries from the fpot where their exuvia are dug out; why fhould we not allow that this new foffil may be the fame original elaftic gum, now growing naturally in Brafil, China, and other hot climates, only altered in its fmell, and in the tenacity of its particles, by its long depofition during centuries in the bowels of the earth?"

This elaftic petrol was found in 1785, near Caffeltown, in the county of Derbyfhire in England, but in very inconfiderable quantities.

D. Hardened rock-oil; foffile pitch. *Petroleum induratum, Pix montana.*

1. Pure afphaltum.

This leaves no afhes or earthy fubftance when it is burnt.

It is a fmooth, hard, brittle, inodorous, black or brown fubftance. When looked through in fmall pieces, appears of a deep red colour. It fwims in water.

It breaks with a fmooth fhining furface.—Melts eafily: and, when pure, burns without leaving any afhes; but if impure, leaves afhes or a flag.

According to M. Monet, it contains fulphur, or at leaft the vitriolic acid.

It is flightly and partially acted on by alcohol and æther.

From this, or the preceding fubftance, it is probable the afphaltum was prepared that the Egyptians ufed in embalming their dead bodies, and which is now called *mummia*.

It is found alfo on the fhores of the Red Sea, in the Dead Sea, in Germany, and France.—(*Kirwan.*)

And it comes likewife from Porto Principe, in the ifland of Cuba. (*Brun.*)

It is found alfo in many parts of China: and is employed as a covering to fhips by the Arabs and Indians. (*Fourcroy.*)

2. Impure; *Pix montana impura.* Piffaphaltum.

This contains a great quantity of earthy matter, which is left in the retort after diftillation, or upon the piece of charcoal, if burnt in an open fire; it coheres like a flag, and is of the colour of black-lead: but in a calcining heat, this earth quickly volatilifes, fo that the nature of it is not yet known.

It is found in Moffgrufvan in Norberg, and in Grengierberget, both in the province of Weftmanland; and alfo in other places.

The piffaphaltum is of a mean confiftence between the afphaltum and the common petroleum. It is the very bitumen which is collected in Auvergne in France in the well called *de la Pege*, near Clermont Ferrand.

VIII. Jet. *Gagas, Succinum nigrum.*

This is a very compact bitumen, harder than afphaltum, always black, and fufceptible of a good polifh. It becomes electrical when rubbed; attracts light bodies like the yellow amber; and it fwims on water.

It feems to be nothing elfe than a black amber, or fuccinum; but fpecifically lighter, on account of the greater portion of bitumen that enters into its compofition. When burned, it emits a bituminous fmell. See the article Jet.

IX. Mineral phlogifton united with earths.

A. With calcareous earth.

1. With pure calcareous earth. This is the fetid or fwine fpar formerly defcribed.

B. United with calcareous, argillaceous, ponderous, and filiceous earth and vitriolic acid. Liverftone: *Lapis hepaticus.*

C. With an argillaceous earth; Pit or Stone Coal.

1. With a fmall quantity of argillaceous earth and vitriolic acid. *Lithanthrax.* See the articles Coal and Pit-coal.

This is of a black colour, and of a fhining texture: it burns with a flame, and is moftly confumed in the fire; but leaves, however, a fmall quantity of afhes.

a. Solid coal. *b.* Slaty coal.

2. Culm-coal, called *kolm* by the Swedes.

This has a greater quantity of argillaceous earth and vitriolic acid, and a moderate proportion of petrol.

It has the fame appearance with the preceding one, though of a more dull texture: it burns with a flame; and yet is not confumed, but leaves behind a flag of the fame bulk or volume as the coal was.

From England, and among the alum rock at Moltorp and Billingen in the province of Weftergottland.

3. Slate-coal.

This coal contains abundance of argillaceous earth. It burns with a flame by itfelf, otherwife it looks like other flates.

It is found at Gullerafen in the parifh of Rettwik, in the province of Dalarne, and alfo with the coals at Boferup in Skone.

This feems to be the fame with the bituminous fchiftus, already defcribed among the argillaceous earths.

4. Cannel-coal.

Mr Kirwan has put together this variety of coal with that other called *Killkenny-coal*, tho' they have fome different properties.

The cannel-coal is of a dull black colour; breaks eafily in any direction; and, in its fracture, prefents a fmooth conchoidal furface, if broken tranfverfely.

It contains a confiderable quantity of petrol, in

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in a lefs denfer ftate than other coals; and burns with a bright lively flame, but is very apt to fly in pieces in the fire. It is faid, however, to be entirely deprived of this property, by being previoufly immerfed in water for fome hours.

Its fpecific gravity is about 1270; and being of an uniform hard texture may be eafily turned in the lathe, and receive a good polifh.

It is from this kind of coal that fmall vafes, as ink-ftands, various trinkets, and other curiofities, are made in England, which appear as if made of the fineft jet.

5. Kilkenny-coal.

This contains the largeft proportion of petrol or afphaltum; burns with lefs flame and fmoke, and more flowly, though intenfely, than the cannel-coal.

The quantity of earth in this coal does not exceed one twentieth of its weight. Its fpecific gravity is about 1400. It is frequently mixed with pyrites.

It is found in the county of Kilkenny, belonging to the province of Leinfter in Ireland. The quality of this coal burning almoft without fmoke, is mentioned in a proverb by which the good qualities of this county are expreffed.

6. Sulphureous coal.

This confifts of the former kinds of coal, mixed with a notable proportion of pyrites: hence it is apt to moulder and break when expofed to the air. It contains yellow fpots that look like metal; and burns with a fulphureous fmell, leaving either red afhes, or a flag, or both. Water acts upon it, after it has mouldered. Its fpecific gravity is = 1500, or more.

Befides the above varieties, fchiftus, micaceous fchiftus, and gneifs, are frequently found in the neighbourhood of coal-mines, fo penetrated with petrol bitumen as to conftitute an inferior fpecies of coal; but the bitumen being burnt, they preferve their form, and in fome meafure their hardnefs. Alfo fome grey flates, that are fo foft as to be fcraped with the nail, and are greafy to the touch, burn like coal.

All the differences of coal arife from a mixture of the varieties already mentioned; and it is obfervable, that wherever coals exift, flates are generally found near them. Salt or mineral fprings are alfo often found in their neighbourhood. (*Kirwan.*)

7. Bovey coal. *Xylanthrax.*

This is of a brown, or brownifh black colour, and of a yellow laminar texture.

The laminæ are frequently flexible when firft dug, though generally they harden when expofed to the air.

It confifts of wood penetrated with petrol or bitumen; and frequently contains pyrites, alum, and vitriol.

Its afhes afford a fmall quantity of fixed alkali, according to the German chemifts; but according to Mr Mills they contain none.

By diftillation it yields an ill fmelling liquor, mixed with a volatile alkali and oil, part of which is foluble in fpirit of wine, and part infufible, being of a mineral nature.

It is found in England, France, Italy, Swifferland, Germany, Ireland, &c. (*Kirwan.*)

8. Peat. *Geanthrax.*

There are two forts of inflammable fubftances known by this name, viz.

The firft of a brown, yellowifh brown, or black colour, found in moorifh grounds; in Scotland, Holland, and Germany. When frefh, it is of a vifcid confiftence, but hardens by expofure to the air. It confifts of clay mixed with calcareous earth and pyrites; and fometimes contains common falt. While foft, it is formed into oblong pieces for fuel, after the pyritaceous and ftony matters are feparated. When diftilled, it affords water, acid, oil, and volatile alkali. Its afhes contain a fmall proportion of fixed alkali. They are either white or red, according as it contains more or lefs ochre or pyrites.

The fecond is found near Newbury in Berkfhire. It contains but little earth; but confifts chiefly of wood, branches, twigs, roots of trees, with leaves, grafs, ftraw, and weeds. (*Kirwan.*)

9. Stone-turf.

Cronftedt has ranged the turf among the foffils of his Appendix; but as that called in England by the name of *ftone-turf* contains a confiderable proportion of peat, it may be mentioned with propriety in this clafs.

Soon after it is dug out from the ground, where it keeps a foft confiftence, it at firft hardens; but afterwards it crumbles by long expofure to the air.

As to the other common turf, it only confifts of mould interwoven with the roots of vegetables; but when thefe roots are of the bulbous kind, or in a large proportion, they form the worft kind of turf.

Although it may appear incredible, it is neverthelefs a real fact, that in England pit-turf is advantageoufly employed in Lancafhire to fmelt the iron-ore of that county. Mr Wilkinfon, brother-in-law to Dr Prieftley, and famous for his undertakings in the extenfive ironworks, perhaps the greateft in Europe, makes ufe of pit-turf in his large fmelting furnaces of that province.

Those foffil fubftances, which furnifh fuel for the various purpofes of human life, are diftinguifhed by the name of *coals*, on account of their being a fuccedaneum for wood and other vegetable productions, which, when dry or of an oleaginous kind ferve for the fame ufes. If thefe vegetable fubftances are deprived of the accefs of air, by covering them after ignition, the half-confumed remainder, which is of a black colour, is called by the name of *coal* or *charcoal;* and from hence the foffil which affords fuel has alfo

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alfo been called by the fame name, though of a very different nature.

Pit-coal and earth-coal are fynonymous, and mean coals dug out of a pit or from the earth. But the lithanthrax denotes ftone-coal, and more properly indicates the cannel-coal, which has the greateft fimilarity to a ftony fubftance, by the dull appearance of its fracture and by the uniform texture of its parts.

All thefe coals are in general a bituminous black or brown and dark fubftance: for the moft part they have a lamellated texture, which breaks eafily, and always with a fhining furface.

The varieties of pit-coals above-mentioned are the moft remarkable, by which they may be diftinguifhed from one another. But they are far from being homogeneous in each kind; as the accidental qualities, and the various proportions of their component parts, produce a far greater number of properties, which renders them more or lefs fit for different purpofes; though thefe are generally overlooked, and confounded with the common one of affording fuel for making fire to warm our rooms, or for culinary operations.

This foffile bitumen, as Fourcroy remarks, being heated in contact with a body in combuftion, and a free accefs of air, kindles the more flowly, and with more difficulty, as it is more weighty and compact. When once kindled, it emits a brifk and very durable heat, and burns for a long time before it is confumed. If extinguifhed at a proper time, the remaining cinders may ferve feveral times for a new firing with a fmall addition of frefh coals. The matter that is burned, and produces the flame, appears very denfe, as if united to another fubftance which retards its deftruction. Upon burning, it emits a particular ftrong fmell, which is not at all fulphureous when the earth-coal is pure, and contains no pyrites.

When the combuftible, oily, and moft volatile parts, contained in the earth-coal, are diffipated and fet on fire by the firft application of heat; if the combuftion is ftopped, the bitumen retains only the moft fixed and leaft inflammable part of its oil, and is reduced to a true charry ftate, in combination with the earthy and fixed bafe. Pit-coals in this charry ftate are called *coaks*, which are capable of exciting the moft intenfe heat; and are employed all over Britain in the fmelting of iron, copper, and other metallic ores, to the greateft advantage. See COAKS, COAL, COALERY, and PIT-COAL (E).

X. The

‡ Nat. Hift. of the Mineral Kingdom.

(E) The coal-metals, or ftone ftrata inclofing coals, are very numerous. Mr Williams ‡ gives the following general account of thofe in Scotland.

The fand-ftones. Of thefe there is a great variety, diftinguifhable by colour, texture, and degrees of hardnefs, generally difpofed into thick, middling, and thin ftrata. The only fpecies our author takes notice of is the regular broad-bedded free-ftone of a laminated texture. This commonly rifes in thin or middling ftrata; appearing at the edges of a fection, when broken or cut, to be formed of thin lamina or layers of fand, equally laid on the whole breadth of the ftone, and well cemented together. A great deal of both red and white free-ftone rife in layers of five or fix inches, and fo upwards, with regular ftreaks of a fifth or fixth part of an inch appearing the whole length of the ftone, when the edge of a flab is polifhed, as if fo many gentle waves of water had formed the layer. The regularity of the ftructure of this ftone correfponds exactly with the regularity of its layers; and our author is of opinion, that the flaggy grey-ftrata of free ftone, with many of the black and grey-ftrata of coal metals, the grey flate, as well as many other thin ftrata of the coal metals, may be ranked with this free ftone for perfect and regular ftratification.

Along with thefe he claffes fome of the thin argillaceous ftrata. "Many of the grey regularly ftratified mountain limeftones (fays he) are alfo ftreaked or ftriped; and the ftreaks in thefe appear more confpicuous when broken than the ftreaked free ftones. Some of the hard regularly ftratified mountain rocks are alfo ftratified; and in all thefe three kinds of ftones, the ftreaks are regularly and exactly parallel to the bed of the ftone."

Another remarkable inftance of regularity of ftrata is met with in the grey flaggy ftrata of Caithnefs.—Throughout all the low country of Caithnefs, a fquare of about 10 or 15 miles, there are bluifh argillaceous ftrata, with generally a fmall quantity of lime in the compofition of the ftone, which is indurated to a greater degree than is common to fuch thin ftrata, The ftone is ftrong and tough, every where difpofed in thin broad-beded, regular ftrata; and in feveral parts of the country the flags are fo thin and regular, and are raifed fo light and broad, that they are ufed for covering houfes; and three or four of them will cover the fide of a fmall one. Our author mentions a gentleman who has an eftate on the fouth fide of the Pentland frith, and who in a bay there raifes flags of any fize and thicknefs he pleafes; "fo truly flat and fmooth, that he has only to fquare the edges to make of them good loft-floors, partitions, chefts, mangers, roofs of houfes; in fhort, he does every thing with them. The face of thefe flags are as fmooth and true a plane, as if artificially finifhed by the beft workman."

In moft coal fields there are a great variety of ftrata of different kinds accompanying and lying between the feams of coal, of all forts of colours, confiftencies, and dimenfions; all of them blended together without any certain order or regularity; fo that if there be 20 feams of coal, it is poffible that there may be as many different roofs; that is, the ftratum which is the immediate roof of one feam of coal, fhall differ from that of another feam in quality, thicknefs, and colour, fo that perhaps no two of the twenty fhall be in any refpect alike.

The various kinds of coal-roofs (*a*) commonly met with are the following.

1. Ba-

(*a*) The ftratum which is placed immediately above a feam of coal, is called the *roof* of the coal, and that which is placed immediately below the feam, is called the *pavement* of the coal: which three, viz. the ftratum of coal, and its roof and pavement, with the other concomitant ftrata lying above and below them, always preferve their ftations and parallelifm; that is, are all ftretched out and fpread one above another upon the fame inclining plane, and have the fame line of bearing and of declivity.

Inflammables.

X. The mineral phlogifton or bitumen, united with the vitriolic acid: fulphur or brimftone. See the article SULPHUR.

This is very common in the earth, and difcovers itfelf in many and various forms. It is found,

A. Native. *Sulphur nativum.*

In this the two conftituent parts are mixed in due proportion in regard to each other, according to the rules of that atttraction which is between them. It is eafily known,

1. By its inflammability, and by its flame.
2. By its fmell when burnt; and,

O 2 3. By

1. *Bafaltes.* This is very common in Scotland, where it is frequently called *whin* ftone; and at Borrowftounnefs there are feveral thick beds of it between the feams of coal. One of them being the immediate roof of a feam of coal there at Hillhoufe lime quarry, there is a thin feam of coal beneath a beautiful bed of columnar bafaltes. In the Bathgate hills to the fouthward of Linlithgow, alfo, there are feveral ftrata of coal blended with thofe of bafaltes. Thefe bafaltine ftrata are always very hard, frequently very thick, and generally of a black or blackifh grey colour. "There are but few people (fays Mr Williams) fufficiently verfed in natural hiftory, to know that they are bafaltes, as this kind of rock, both in England and Scotland, goes by the name of *whin rock*. In the north of Scotland it is called *fkurdy*; and among the miners in Cornwall it has the name of *cockle* (*b*)."—

2. Strata of *limeftone* of various thickneffes are met with in different coal-fields. Sometimes the lime is the immediate roof; but fometimes there is an argillaceous ftratum of about the thicknefs of a foot between the coal ftratum and that of lime. In the coal-fields at Gilmerton, near Edinburgh, are feveral beds of limeftone, fome of them very good, and of confiderable thicknefs. At Blackburn in Weft Lothian, alfo, there is a ftratum of limeftone fix or feven feet thick, which is the immediate roof of a feam of coal about five or fix feet thick. At Carlops and Spittlehaugh in Tweedale, they have a feam of coal immediately below their lime quarries, which they work for burning their lime.

3. *Poft-ftone*, a kind of thick and folid ftratum of free ftone, is one of the roofs of coal, generally without the intervention of any argillaceous ftratum, though fometimes a ftratum of this kind is interpofed. Frequently this kind of ftone is rendered very hard by a mixture of iron or pyrites. In moft coal fields, thinner ftrata of free ftone are met with as the roofs of coal feams.

4. *Dogger-band*, as it is called by the Scots colliers, is frequently met with as the roof of coal feams. This name is applied to various fubftances. Sometimes they call ftrata of iron-ftone *dogger bands*; fometimes the name is reftricted to the ball iron-ftone; fometimes to pyrites; and fometimes the dogger band is a kind of imperfect ftone, compofed of feveral heterogeneous mixtures, among which pyrites bears a confiderable proportion, and by which the whole is fo ftrongly bound together, that it is frequently very difficult to break through it.

5. *Whin-ftone*, properly fo called, not of a bafaltic nature. Thefe roofs are always very hard, and of various colours, as black, blackifh grey, brown, red, &c. fometimes not above two or three feet in thicknefs, but fometimes much more.

6. *Poft-ftone*, of a fofter nature than that already mentioned. This has no mixture of ferruginous matter.

7. *Regular ftrata of free-ftone*, of various colours, textures, and thickneffes, but not fufficiently thick to deferve the name of *poft-ftone*, which our author thinks they do not, unlefs they are above three or four feet. Thefe thin ftrata of free ftone are very numerous in coal fields, and very frequently form the roofs of coal-feams. Some of them are three or four feet thick, while others do not exceed three or four inches. They make good roofs, eafily cut through, and may be readily quarried out for other purpofes.

8. *Grey-bands*, or grey-coloured free-ftone, frequently form the roofs of coal feams. A great number of them are generally arranged in one place, lying immediately above one another; and they are frequently found of all degrees of thicknefs from one to twenty inches, though the moft common dimenfions are from two to fix. By the Scots colliers thefe are called *grey fekes* as well as grey bands. Frequently they are found of moderate hardnefs, and fufficiently ftrong to make good flags and covers for fewers. Thefe roofs are ftrong and fafe when the ftone partakes of the nature of the coal, and has a black or blackifh grey colour; but when they have a mixture of tilly or argillaceous matter, they are more friable.

9. *Blaes*, when hard, ftrong, and well ftratified, are reckoned tolerably good coal-roofs. Thefe are always of a bluifh-black or black-grey colour, and are of great variety in refpect to hardnefs and ftrength. Some of the ftrongeft and hardeft are either entirely black or greyifh black; while fome of the different fhades of black are pretty thick, and others are but thin. The thickeft, however, are not above 18 inches, and the thinneft two or three inches or lefs. The medium thicknefs is from one foot to three or four inches. Some of them are fufficiently hard to make a good and fafe coal-roof; but they feldom acquire fuch a degree of hardnefs as to give any confiderable obftruction in fucking. All of them feem to have a confiderable quantity of black argillaceous matter in their compofition; and the ftrong blaes have alfo a confiderable quantity of fand; often alfo containing a large portion of empyreumatic oil, and fometimes have a confiderable mixture of coaly matter. There is a great variety both in the thicknefs and quantity of thefe blaes found above feams of coal. In fome places the thinneft ftrata make the immediate roof; in others, the thickeft. Sometimes we find only five or fix inches of blaes upon the coal; in others as many fathoms, or even much more; and it is common to find them of all the intermediate thickneffes.

10. *Whitifh*

(*b*) We muft obferve, however, that according to Bergman and other eminent mineralogifts, the *cockles* or *fhirls* ought not to be confounded with *bafaltes*; which laft name does not at all fit thofe fubftances. See *Volcanic Products* in the Appendix to this article.

Inflammables.

3. By its producing a liver of sulphur, when mixed with a fixed alkali, like that made from artificial sulphur. It is found,

a. Pellucid, of a deep yellow colour.

b. Opaque, white, and greyish.

These are found in Siberia, at Bevieux in Swisserland, and at Salfatara near Naples.

c. Crystallised in octoedral prisms, with blunted points.

d. Transparent. Mr Davila had been informed that this was brought from Normandy in France. (*Brun.*)

Inflammables.

1. Native sulphur is found in different forms, *viz.* either in solid pieces of indeterminate figure, running in veins through rocks; or in small lumps, in gypsum and limestones; in considerable quantities at Solfatara, and in the neighbourhood of volcanoes; or crystallised in pale, transparent, or semitransparent, octogonal, or rhomboidal crystals, in the cavities of quartz; and particularly in the matrices of ores; or in the form of small needles over hot springs, or near volcanoes (*Kirwan*).

Some-

10. *Whitish and ash-coloured argillaceous strata*, of middling strength, are frequently found to be the immediate roofs of coal. Some of these are of middling thickness, others thin. They are commonly found from two inches to two feet in thickness. A great many of these roofs are very dangerous on account of their fragility; while others are quite safe, owing to the more perfect formation of their strata, or to some ingredient in their composition.

11. *Streaked roofs.* These are of two sorts: 1. Such as are composed chiefly of sand, with a very small mixture of clay and blaes; and, 2. Those composed principally of clay or blaes with a small quantity of sand. Some of these have large, others small, streaks or ribs. Mr Williams says that he has seen them so beautifully streaked as to resemble the finest striped cotton stuffs. These stripes or streaks always lie exactly parallel to one another, as well as to the bed of the stone, and are always spread out the whole breadth of the stratum. Their colours are various in different strata, some of the stripes being nearly black and white, others white and red, and others yellow and red. In some the stripes appear of a lighter and darker grey colour. Some of the finely striped stones have their streaks about a quarter of an inch in diameter; sometimes less: and it is common to see stripes from a quarter to three quarters of an inch broad; but in the finely striped stones it is rare to find them a full inch thick without some different shade on one side or other of the stripe. The second kind of these streaked roofs, viz. such as are composed of blaes, with a smaller mixture of sand, differ but little from the former; only the colours are not always so bright, nor the stripes so fine; neither is the roof quite so hard.

12. *The soft blae roofs* sometimes consist of pretty thick strata; others of such as are thin or of middling thickness. There are likewise arrangements or classes of regularly stratified blaes, found immediately above seams of coal, from three or four inches to several fathoms in thickness, though some are even met with little exceeding one inch in thickness; though in the same place there might be a considerable thickness of blaes above the coal, taking in all the different strata, thick and thin, which lay above it. Some of these roofs have an oily appearance on the outside, and through all the fissures and joints of the strata; that is, they appear smooth and glossy, and are very slippery to the touch. Others have no appearance of this kind; but all of them are tender, weak, and fragile, so that they make a very indifferent and dangerous roof.

13. Another kind of coal-roof consists likewise of *blaes*, but such as are *imperfectly stratified*. It is altogether the same in quality and colour as the last, the only difference that can be distinguished being in the different degrees of stratification. The beds of this kind are not perfect, but unequal; whence it is a bad and dangerous roof, as great pieces of it are frequently apt to fall down by reason of the inequality and different joints of the strata. Some of these blaes appear in thick, and others in thin or middling thick beds; while some have an oily smoothness, called by the Scots colliers *creeshy* (greasy) *blaes*. It is owing to this oiliness particularly that these kinds of roofs are so dangerous; for the oil pervades the joints, and, rendering them slippery, makes the pieces more apt to fall out as soon as the coal is worked away from below them. Some of these have such a quantity of natural oil, that they will flame a little in the fire; and in some places there are hard blaes which will burn when fire is set to them, though they will not consume. At Pitfirran in Fifeshire there is a species of this blaes so inflammable, that when fire is set to one corner of a hillock it will burn throughout the whole; nevertheless it is not reduced in bulk by this combustion, nor does it produce any ashes. Instead of this it becomes considerably harder than before, and acquires a pale red colour. By reason of its hardness, it is proper for being laid upon horse and foot paths, but is not so for roads over which heavy wheel-carriages pass.

14. *Soft blaes not stratified at all.* Of these there is no more than one bed from two or three inches to several fathoms in thickness, without any others either above or below it. They are as common as any above the coal seams; but their substance is not always uniform throughout the whole stratum. Some of them are found divided into small angular masses, and others into larger ones; but whether these are uniform or not, they always make a bad and dangerous roof. These argillaceous strata are sometimes called *beds of till*; the uniform sort are called *dauk*, and the glebous kind *lipey* blaes, by the Scots colliers. Both the uniform and glebous soft blaes frequently contain a quantity of ball iron-stone, though some of it contains none at all. The regular continuous strata of iron-stone are commonly found in stratified soft blaes. There is a variety of soft coal-roofs of a grey colour, and of which some are regularly stratified, and some not.

15. *Re-*

Inflammables.

Sometimes it is formed in old privies: of this Mr Magellan faw fome lumps that were found in a very old one at Paris.

2. United with clay in the aluminous ore of La Tolfa, and alfo at Tarnowitz in Silefia. This laft refembles a light grey earth: when dry, burfts or cracks in the water like marl; and poffeffes a ftrong peculiar fmell like camphor. If diftilled, the fulphur fublimes. One hundred parts of this earth afford eight of fulphur, befides gypfum and a quantity of iron.

3. Mixed with clay, iron, and felenite. This compound is of a grey, brown, or black colour, found near Rome, Auvergne, Spain, and Iceland.

4. With limeftone in the form of a calcareous hepar. This is found at Tivoli, near Rome, and elfewhere in Italy. It is fometimes diffolved in mineral waters, three pounds of which contain as much as 25 grains of fulphur. It often forms incruftations on the brinks of thefe fprings.

5. In the form of an alkaline hepar. This is faid to be found in fome waters in Ruffia; as will be hereafter noticed.

6. United to iron and clay of pyrites, &c. of which hereafter.

7. United to metallic fubftances, as hereafter fpecified.

B. Saturated with metals (F).

1. With iron. Pyrites, or copperas-ftone; *Pyrites.*

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15. *Regularly foft grey coal-roofs.*—Of thefe there are feveral forts. Some have a confiderable quantity of fand in the compofition of the ftrata; and many of thefe are as regularly ftratified as any coal-metals whatever. Numbers are found very thin, and others of middling thicknefs; though in all cafes they are fo tender and friable, that they make very bad and dangerous roofs. Some of them indeed look pretty well at firft but they foon crumble and come down, efpecially when they have been expofed to the air. This, in the opinion of Mr Williams, is owing partly to their having too much clay in their compofition, and partly to the want of a fufficient quantity of natural cement to connect the feveral particles of the ftone together.

16. *Soft grey regular ftrata*, or grey bands of an argillaceous kind; and of thefe there is likewife a confiderable variety. Some are of a dark, others of a lighter grey; fome thick, others thin: they are very numerous in coal-fields, and are frequently to be found as the immediate roofs of coal. Thefe, as well as the black kinds, are found in all quantities or degrees of thicknefs above different coals, from a few inches up to feveral fathoms; but whether they be in great or fmall quantity, the roof they compofe is generally very frail and tender.

17. *Soft grey argillaceous bands, imperfectly ftratified.* Thefe differ little or nothing in fubftance from the former; the only difference is in the ftratification. Many of the ftrata of the former are of a middling thicknefs, or rather thin, finely and regularly fpread out, and every part of each ftratum of an equal thicknefs. But this fort, though it has the appearance of ftrata, is clumfy and irregular; that is, the feveral beds are unequal, and divided by many irregular joints into unequal mifhapen maffes, which makes this a very bad roof; the maffes being apt to feparate at the joints, and to fall down when the coal is worked out from below them.

18. *Soft grey argillaceous beds* of metal or coal roofs *not ftratified at all.* Thefe are of two kinds, *viz.* 1. fuch as are found broken or formed in the ftratum into glebes or maffes; and, 2. fuch as are found in one uniform mafs throughout the whole bed, without any divifion into maffes or ftrata. Thefe grey foft roofs are of all degrees of thicknefs, from a few inches up to many fathoms, as well as the black; and there is but very little difference between them in any refpect excepting the colour. But in this, as well as in the black unftratified blaes, and that both in the glebous and uniform beds, ball or glebous iron-ftone is frequently found; and ftrata of iron-ftone are alfo found in the ftratified foft grey blaes.

19. *White and afh-coloured foft argillaceous coal-roofs*; and of thefe there is alfo a great variety. Some of this kind are regularly ftratified, others imperfectly, and fome not at all. Some of the whitifh argillaceous roofs are compounded of gritty fand and clay; others appear to be chiefly compofed of pure clay; and fome of a loamy clay. Thofe which are regularly ftratified and mixed with fand, either coarfe or fine, are of great variety with regard to thicknefs and the arrangements of the ftrata; but all of them are tender and fragile, and thus make very troublefome and dangerous roofs.

20. *Whitifh argillaceous roofs, ftratified*, and of a homogeneous quality, or not mixed with fand. Some of thefe are finely and perfectly ftratified, and are of different degrees of hardnefs; but in general, make but a weak roof. Some of them are found in irregular ftrata, with all the other varieties and imperfections already mentioned.

21. *White and afh-coloured argillaceous coal-roofs*, not *ftratified at all.* Sometimes thefe are found in very thick beds in the coal-fields; and fome of thefe, as well as of the black foft roofs, rife in glebes and maffes of different fizes; while others are homogeneous throughout the whole bed, however thick, from two or three inches to feveral fathoms. Some of thefe beds of white argillaceous marle-like matter are found to be a fandy or loamy clay; others a pure homogeneous clay, which does not feel gritty between the fingers nor in the mouth. The fhades and varieties of this kind are as numerous as thofe of any of the foregoing; and all of them, by the Scots colliers, are called *dauk*, whatever be their coour. Mr Williams informs us, that he has frequently taken fome of thefe fine white clays to wafh his hands, and has found them anfwer almoft as well as foap.

(F) Sulphur is the moft common mineralifer of metals; and therefore moft of its combinations with thofe fubftances fall to be ranked hereafter among the metallic ores.

Inflammables.

rites. This is the ſubſtance from which moſt ſulphur is prepared, and is therefore ranked here with all its varieties. It is hard, and of a metallic ſhining colour.

A. Pale yellow pyrites; *Pyrites ſubflavus*. Marcaſite. This is very common, and contains a proportionable quantity of ſulphur with reſpect to the iron; when once thoroughly inflamed, it burns by itſelf.

a. Of a compact texture; *Polita piedra del ynca, Hiſpanorum.*

b. Steel-grained.

c. Coarſe-grained.

d. Cryſtalliſed. It ſhoots moſtly into cubical and octoedral figures, though it alſo cryſtalliſes into innumerable other forms.

B. Liver-coloured marcaſite. Its colour cannot be deſcribed, being betwixt that of the preceding marcaſite and the azure copper ore. The iron prevails in this kind; it is therefore leſs fit to have ſulphur extracted from it, and alſo for the ſmelting of copper ores. It is found,

a. Of a compact texture.

b. Steel-grained.

c. Coarſe-grained.

C. Variouſly combined with iron and other metallic ſubſtances.

1. With iron and copper; forming yellow or marcaſitical copper ore.
2. With iron, ſilver, and lead; potters lead ore.
3. With iron and zinc; mock lead, black jack or blende.
4. With iron and arſenic; arſenical pyrites.
5. With iron and cobalt.
6. With iron and biſmuth.
7. With iron and nickel.
8. With iron and gold; pyritical gold ore.
9. With ſilver; glaſs ſilver ore.
10. With copper; grey or vitreous copper ore.
11. With lead; potters lead ore.
12. With biſmuth.
13. With quickſilver; cinnabar.
14. With arſenic; orpiment, realgar.

XI. Mineral phlogiſton mixed with metallic earths.

This is not found in any great quantity: in regard to its external appearance, it reſembles pit-coal; and the fat ſubſtance contained in it, at times, partly burns to coal, and partly volatiliſes in a calcining heat.

The only known varieties of this kind are,

A. Minera cupri phlogiſtica.

When it has been inflamed, it retains the fire, and at laſt burns to aſhes, out of which pure copper can be ſmelted.

B. Minera ferri phlogiſtica.

Metals.

This is not very different in its appearance from the pit-coal or foſſile pitch, but it is ſomewhat harder to the touch. There are two varieties of this ſpecies:

1. Fixt in the fire; *Minera ferri phlogiſtica fixa.*

Expoſed to a calcining heat, it burns with a very languid though quick flame; it preſerves its bulk, and loſes only a little of its weight. It yields above 30 per cent. of iron.

a. Solid, which reſembles black ſealing-wax.

b. Cracked, and friable.

2. Volatile in the fire.

This is unalterable in an open fire, either of charcoal, or even upon a piece of charcoal before the flame of the blow-pipe; but under a muffle the greateſt part of it volataliſes, ſo that only a ſmall quantity of calx of iron remains. It is found,

a. Solid.

b. Cracked.

This laſt kind leaves more aſhes: theſe aſhes, when farther expoſed to the fire, become firſt yellowiſh-green, and afterwards reddiſh-brown; when, beſides iron, they then alſo diſcover ſome marks of copper: it has, however, not been poſſible to extract any metallic ſubſtance from them, the effects of the loadſtone, and the colour communicated to the glaſs of borax, having only given occaſion to this ſuſpicion.

Class IV. METALLIC SUBSTANCES.

Metals are thoſe minerals which, with reſpect to their volume, are the heavieſt of all known bodies. Some of them are malleable; and ſome may be decompounded; and, in a melting heat (G), be brought back again to their former ſtate by the addition of the phlogiſton they had loſt in their decompoſition. See Metallurgy, Part I. Sect. i. and Chemistry-*Index* at *Metallic Calces* and *Metals*.

All the metallic ſubſtances contain phlogiſton; and when, to a certain degree, deprived of it, fall into a powder like an earth; but their attractions for phlogiſton are different.

Moſt of them, when melted in a common way, and expoſed to the air, have an earthy cruſt formed upon the ſurface, which cannot again be reduced to metal without the addition of ſome inflammable matter. The baſe metals have this property.

But the noble metals, *viz.* platina, gold, and ſilver, are ſo firmly united to the phlogiſton, that they never calcine under fuſion, however long continued; and, after being changed into a calx in the liquid way, when melted in the fire, they reaſſume their metallic form without any other phlogiſton than what is contained in the matter of heat.

Quick-

(G) The various degrees of heat required to reduce metals to a fluid ſtate, are ſeen in the following table, which was extracted, for the moſt part, by Dr Withering, from the printed treatiſes of the late celebrated Profeſſor Bergman. It exhibits, in a ſimple view, 1. The ſpecific gravity of each metal; 2. The degree of heat by Fahrenheit's ſcale, in which it melts; 3. The quantity of phlogiſton it requires for its ſaturation; and,

4. Its

METALS.

Quickfilver holds a kind of middle place: for, like the bafe metals, it may be calcined, though not readily; and, like the noble ones, it may be reduced by heat alone.

We may therefore reckon four noble or perfect metals; *viz.* gold, platina, filver, and mercury; becaufe, when calcined, they recover their phlogifton without the addition of any phlogiftic fubftance.

But as tin, lead, copper, and iron, cannot be reduced without fuch addition, thefe are called *ignoble* and *imperfect* or *bafe metals*. *Kirwan's Mineralogy*.

However, all thofe eight metals (even mercury, when folid) are malleable to a confiderable degree, and are called *entire metals*. But

Bifmuth, zinc, antimony, arfenic, cobalt, nickel, manganefe, molybdena, and wolfram, are fcarce at all malleable, and hence they are called *femimetals*. Neverthelefs, zinc and purified nickel are more malleable than any of the other femimetals; fo that we have four perfect or noble metals, four imperfect or bafe, eight entire, and nine femimetals (H).

Order

4. Its attraction to the fame faturating phlogifton. We muft, however, obferve, that if the fecond column be compared with that of Wedgwood's thermometer, their great difagreements betray fome fundamental error in the affumed data: for the degrees of heat affigned by Mr Wedgwood for melting gold, filver, and copper, are more than quadruple of thofe affigned by Bergman, and that for melting iron is more than eleven times greater; although they both nearly agree in the red heat of iron, which Bergman fays to be 1050 degrees, and Wedgwood 1077. Mr Magellan is of opinion, that the fault lies in Mortimer's thermometer, which Bergman quotes with fome diffidence (Sect. 197. of his *Sciagraphia*); and thinks it probable, that the changes caufed by heat, on this metallic thermometer, are in a much lefs increafing proportion by intenfe fire, than thofe indicated by the contraction of the pure clay, happily employed by Wedgwood in his thermometer. He therefore added another column to this table, marked *Wedgw.* with the degrees of the melting heats already afcertained by this laft thermometer, as being the neareft to truth.

Metals.	Specific Gravity.	Melting Heat. *Berg*	Melting Heat. *Wedgw.*	Saturating Phlogifton.	Attraction to faturating Phlogifton.
Gold - -	19,640	1301	5237	394	1 or 2
Platina - -	21,000			756	1 or 2
Silver - -	10,552	1000	4717	100	3
Quickfilver -	14,110	—40	—40	74	4
Lead - -	11,352	595		43	10
Copper -	8,876	1450	4587	312	8
Iron - -	7,800	1601	17977	342	11
Tin - -	7,264	415		114	9
Bifmuth - -	9,670	494		57	7
Nickel, common	7,000	1301		156	11
Nickel, pure	9,000	1601		109	5
Arfenic - -	8,308				
Cobalt, common / pure	7,700	1450 / 1601			
Zinc - -	6,862	699		182	11
Antimony -	6,860	809		120	6
Manganefe -	6,850	Very great		227	11

N. B. By faturating phlogifton, Profeffor Bergman means to exprefs the proportionate quantities taken away from each metallic fubftance, when diffolved by means of acids, and of courfe reduced to a calciform ftate. The laft column only expreffes their attraction to this part of their phlogifton, not to that which ftill remains united to them in a calciform ftate. *Withering.*

(H) Mr Mongez remarks, that the following are the general properties of metals, when confidered as phyfical bodies; *viz.* their opacity, great fpecific gravity, ductility, tenacity, cryftallization, flavour, and even fmell, at leaft in fome of them.

It is from their denfity that their gravity and opacity proceed; this laft being fuch, that, even reduced to the thinneft plates, no rays of light can pafs through their particles, unlefs there remains an interftice or pore quite free from the metallic fubftance. Gold leaf muft, however, be excepted, which exhibits a fine green by tranfmitted light.

As to their cryftallization, it has been found to take place whenever they are pure, and left to cool very flowly by themfelves, after having been perfectly fufed. (See *Journal de Phyfique* for July 1781, p. 74.) The flavour and fmell above mentioned are very perceptible in the reguline fubftances of arfenic and antimony, as well as in lead, copper, and iron.

All metals are conductors of electricity; and more perfectly fo than any other bodies during their union with phlogifton.

They

METALS. *Gold.*

Order I. NOBLE OF PERFECT METALS.

I. Gold; *Aurum ſol chymicorum.* See the articles GOLD; alſo CHEMISTRY-*Index*; and METALLURGY, Part II. ſect. 1.

This is eſteemed the principal and firſt among the metals; and that partly for its ſcarcity, but chiefly for the following qualities:

1. It is of a yellow ſhining colour.
2. It is the heavieſt of all known bodies, its ſpecific gravity to water being as 19,640 to 1000.
3. It is the moſt tough and ductile of all metals; becauſe one grain of it may be ſtretched out ſo as to cover a ſilver wire of the length of 98 yards, by which means $\frac{1}{705600}$ of a grain becomes viſible to the naked eye.
4. Its ſoftneſs comes neareſt to that of lead, and conſequently it is but very little elaſtic.
5. It is fixed and unalterable in air and water, and is indeſtructible by the common action of fire.

6. When melted, it reflects a bluiſh-green colour from its ſurface.
7. It diſſolves in aqua-regia, in the dephlogiſticated marine acid, and alſo (according to Crell ‡) in an acid obtained by diſtilling vitriolic acid from off mangaeſe.
8. When mixed with a volatile alkali and a little of the acid of nitre, by means of precipitation out of aqua-regia, it burns off quickly, in the leaſt degree of heat, with a ſtrong fulmination.
9. It is diſſolved, *in forma ſicca*, by the liver of ſulphur, and alſo ſomewhat by the glaſs of biſmuth (I).
10. It is not carried away by the antimony during the volatiliſation of that ſemi-metal, and is therefore conveniently ſeparated from other metals by the help of crude antimony; in which proceſs the other metals are partly made volatile, and fly off with the antimony, and partly unite with the ſulphur, to which the gold has no attraction, unleſs by means of ſome uniting body, or by a long digeſtion (K).

METALS. *Gold.*

‡ *Journal de Phyſique*, Oct. 1785. p. 297.

11. The

They are ſoluble either in nitrous acid and in dephlogiſticated marine acid, or in aqua regia; and are precipitable in ſome degree by cauſtic alkalies; and except platina by the Pruſſian alkali.

When dephlogiſticated, they communicate a tinge to borax and to microcoſmic ſalt, or at leaſt render them opaque.

They aſſume a convex ſurface when melted, and even a globular form, if in a ſmall quantity; and though they mix for the moſt part with one another whilſt fuſed, yet they refuſe to unite with unmetallic ſubſtances, even their own calces, iron only excepted, which does to its own calx ſlightly dephlogiſticated and to plumbago. Nickel alſo, and ſome others, may contain ſulphur in their reguline ſtate.

Metals, when calcined, are capable of uniting with other calces and ſalts.

Three of the metallic calces have been found to be of an acid nature; *viz.* the arſenical, molybdenic, and tungſtenic; from which, by analogy, the nature of other calces may be conjectured.

The phlogiſton contained in metals is in a pure ſtate; *viz.* without water and aerial acid, with which it is invariably accompanied in all other compounds except acid airs and ſulphur.

When metallic ſubſtances are naturally found in the earth united to their full ſhare of phlogiſton, and conſequently poſſeſſing their peculiar properties, they are called *native.*

But when they are found more or leſs deprived of their phlogiſton and of their properties, combined with other ſubſtances, they are then called *mineraliſed.* This is the moſt common ſtate of the mineral kingdom. The ſubſtance ſo combined with them is called the *mineraliſer*, and the whole is called *ore;* by which name are alſo diſtinguiſhed theſe earths and ſtones in which metallic ſubſtances are contained.

But if both metallic ſubſtances are mixed together in their metallic or reguline form, without the loſs of phlogiſton, they are then ſaid to be alloyed.

When the mineraliſer is of a ſaline nature, and renders the metallic combination ſoluble in leſs than 20 times its weight of water, the compound is ranged among ſalts. Thus the vitriols of iron, copper, and zinc, are rather claſſed with ſalts than with ores.

The moſt common mineraliſers are, ſulphur, arſenic, and fixed air or aerial acid. The leaſt common are the vitriolic and the marine acids. The phoſphoric has been found only in two inſtances; *viz.* united to lead, diſcovered by Gahn; and to iron, in the ſiderite, as Mr Meyer believes.

Thoſe metallic ſubſtances, mineraliſed by aerial acid, are called *calciform ores.*

M. Magellan obſerves, that if the new doctrine of the French chemiſts, who aſſert, that calces of metals are a compound of dephlogiſticated or vital air with the metallic ſubſtance, were juſt, all calciform ores ſhould produce this vital air inſtead of aerial acid, when they are reduced to their metallic form; which is not the caſe: neither ſhould all the baſe metals and ſemimetals abſolutely require the mixture of ſome phlogiſtic ſubſtance in order to their being reduced from the ſtate of calces to their metallic form, which otherwiſe would be quite uſeleſs, if their reduction ſimply conſiſted in their ſeparation from the vital or dephlogiſticated air.

(I) Neither ſulphur nor fixed alkali has any action on gold; but the liver of ſulphur, which is a compound of both, can diſſolve it in the dry way; ſo that if a proper quantity of gold-leaves be put in a crucible together with liver of ſulphur, and it be melted in a briſk fire, the gold is thoroughly diſſolved; and if the whole be diluted in water, the gold will be kept in the ſolution, and even paſs through the filtre along with it.

(K) Antimony is uſed alſo to refine gold from its alloy, as it attenuates and carries off all other metallic ſubſtances

I

Perfect METALS. Gold.

11. The phosphorus is said to have ingress into gold (L).

12. If mixed with a less portion of silver, platina, copper, iron, and zinc, it preserves tolerably well its ductility. But,

13. When mixed with tin, it becomes very brittle; and it attracts likewise the smoke of that metal, so as to be spoiled if melted in an hearth where tin has been lately melted (M).

14. It requires a strong heat before it melts, nearly as much or a little more than copper.

15. It mixes or amalgamates readily with quicksilver. See METALLURGY, Part II. sect. i. (N).

16. It is not dissolved by the glass of lead, and therefore remains on the cupel.

A. Native gold. With respect to the figure or the quantity in which gold is found in one place, it is by miners divided into,

1. Thin superficial plated or leaved gold; which consists of very thin plates or leaves, like paper.
2. Solid or massive, is found in form of thick pieces.
3. Crystallised, consists of an angular figure.
4. Wash gold, or gold dust, is washed out of sands, wherein it lies in form of loose grains and lumps (O). See other distinctions of form under the article GOLD.

B. Mineralised gold. This is an ore in which the gold is so far mineralised, or so entangled in other bodies, as not to be dissolved by the aqua-regia.

1. Mineralised with sulphur by means of iron. Marcasitical gold-ore; *Pyrites aureus*.
2. By means of quicksilver. It is found in Hungary.
3. By means of zinc and iron, or silver. The Schemnitz blende.

See other varieties of mineralised gold ores under the detached article GOLD, already referred to.

Perfect METALS. Silver.

II. Silver: *Argentum, Luna*. See the article SILVER. See also CHEMISTRY-*Index*; and METALLURGY, Part II. sect. iii. and Part III. sect. iii.

This metal is,

a. Of a white shining colour.

b. Its specific gravity to water is, according to Cronstedt, as 11,091 to 1000; according to Bergman, = 10,552; and according to Kirwan, 11,095.

c. It is very tough or ductile, so that a grain of it may be stretched out to three yards in length and two inches in breadth.

d. It is unalterable in air, water, and fire.

e. It dissolves in the acid of nitre, and also by boiling in the acid of vitriol.

f. If precipitated out of the acid nitre with the common salt, or with its acid, it unites so strongly with this last acid, that it does not part from it, even in the fire itself, but melts with it into a mass like glass, which is called *luna cornea* (P).

3. It

substances mixed with it, without excepting the silver; whilst lead leaves this last behind, and even adds some of its own to the gold. *Pauston*, p. 659.

(L) Gold, reduced into thin leaves, is not acted upon by the phosphoric acid in the humid way, though the fire be urged till luminous decrepitations take place; but when it passes that point which separates the humid from the dry way, Mr Margraaf observed that some purple scoria were formed, which is an indication that this concrete acid had partly calcined the gold during its fusion. *Elements de Chymie de Dijon*, Vol. III. p. 131.

Besides this, a drop of the phosphoric acid on the solution of gold by aqua-regia precipitates the metal in its revived state, as asserted by the academicians of Dijon. *Magellan*.

(M) The fumes of a single grain of tin are capable of rendering hard eight ounces of gold; but it easily recovers its malleability by being melted on the fire. (*Wallerius* and *Bomare's* Mineralogy.) But when gold is mixed with arsenic, cobalt, nickle, bismuth, or with the regulus of antimony, it only loses great part of its malleability; and when in a certain proportion, it may be calcined and vitrified with them.—(*Fabroni*.)

(N) Bergman doubts if ever gold has been found perfectly pure; and Mr Kirwan says that it is very seldom found so, being generally alloyed with silver, copper, or iron, or all three. As to the gold commonly used in toys and other objects of luxury, every one knows that it is purposely debased by the artists with copper or other metals; and of late it has been employed in various pieces of jewellery, to form ornaments of various colours: thus a great alloy of silver (viz. one-third part), gives it a shade of a green colour; a similar quantity of copper, a reddish one; a mixture of arsenic, or filings of steel, in the proportion of one-fourth part, gives it a bluish cast; so that having the yellow naturally in the pure gold, and the white in pure silver, the jewellers have almost all the colours to diversify their work. Even in the currency of money, there is none coined out of pure gold, which, by common agreement, is called *gold of 24 carats*. The gold coin of England, France, and Portugal, only contains 22 parts of pure gold, and two of alloy, viz. it is only 22 carats, in the common saying: that of Spain is but of $21\frac{9}{16}$ carats: but the ducat of Holland is of $23\frac{7}{12}$ carats; and the zecchino of Venice, of $23\frac{5}{12}$ carats: which last therefore, it would seem, is the purest gold coin of Europe. (*Pauston's Metrologie*.)

(O) M. Daubenton, in his Methodical Tables of Minerals, enumerates eight sorts of native gold, viz. 1. In powder; 2. In grains; 3. In small spangles; 4. In masses of lumps; 5. In filaments; 6. In branches like vegetables; 7. In lamella; and 8. In octoedral crystals.—He observes also, that gold, in its reguline state, is formed, either, 1. Into angular crystals, composed of yellow octoedres; or, 2. Into irregular yellow masses, which, being broken, show a granular substance.

(P) The marine acid attracts the calx of silver, but cannot remove its phlogiston; and therefore cannot dissolve

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g. It does not unite with the semi-metal nickel during the fusion.
h. It amalgamates easily with quicksilver.
i. It is in the dry way dissolved by the liver of sulphur.
k. It has a strong attraction to sulphur, so as readily to take a reddish yellow or black colour when it is exposed to liver vapours.
l. It has no attraction to arsenic; whence, when the red arsenical silver ore, or *rothgulden ertz* of the Germans, is put into the fire, the arsenic flies off, and leaves the sulphur (which in this compound was the *medium uniens*, behind, united with the silver in form of the glass silver ore, or glass ertz.
m. It is not dissolved by the glass of lead, and consequently it remains on the cupel.
n. It is exhaled or carried off by volatile metals and acids; as by the vapours of antimony, zinc, and the acid of common salt.
o. According to Cronstedt, it melts more easily than copper; and this was a general opinion. But the contrary, as Mr Magellan remarks, has been proved by means of the nice thermometer lately invented by Wedgewood.—See Thermometer.

Silver is found,

A. Native or pure; which most generally is nearly of 16 carats standard (q.)

1. Thin, superficial, plated or leaved.
2. In form,
   a. Of snaggs, and coarse fibres.
   b. Of fine fibres. Capillary silver.
   c. Arborescent.
   d. Crystalline or figured. This is very rare: it has distinct fibres, with shining surfaces.

B. Mixed or alloyed with other metals.

The following are the known instances of these mixtures:

1. United to gold, (*Bergman's Sciagraphia*, § 154.)
2. Mixed with copper; (*Berg. Sc* § 155.)
3. United to gold and copper; (*Berg. Sc.* § 156.)
4. Amalgamated with mercury, found in the mines of Salberg; (*Foster's notes to Brunnich.*)
5. United to iron; (*Berg. Sc.* § 157.)
6. United to lead, sometimes in such quantities as to be worth the expences attending the separation.
7. United to arsenic; (*Journal de physique*, 1778, p. 50.)
8. United to antimony; (*Berg. Sc.* § 159.)
9. Joined to the regulus of arsenic and iron; (*Berg. Sc.* § 160.)
10. Mixed with the alkaline limestone from Annaberg, described by Mr Justi; (*Brunnich.*)
11. Sandy silver-ore, without any metallic shining.
12. Silver-ore in a red-brown schistus, described by Lehman: it is composed of argillaceous earth, micaceous hematites, sulphur, calcareous spar, fluor mineralis, lead, and silver.—It contains about seven or eight ounces of silver on the hundred weight.
13. Soft silver-ore. It is found among the marles and argillaceous earths; and is of various colours, either singly or mixed.

C. Dissolved and mineralised.

(1.) With sulphur alone. Glass silver-ore.

This is ductile, and of the same colour as lead; but, however, becomes blacker in the air. It has therefore, though very improperly, got the name of *glass-ore;* for that name rather belongs to the *minera argenti cornea*, or horn silver ore, if indeed any silver ore can be considered as glassy.

It is found,

1. In crusts, plates, or leaves.
2. Grown into
   a. Snaggs, and
   b. Crystalline figures.
   It is generally either of a lamellar or a grained texture.

The glass silver ore is the richest of all silver ores; since the sulphur, which is united with the silver in this ore, makes but a very small quantity of its weight.

(2.) Arsenico-martial silver ore, (*Weill ertz*, Germ.)

This ore contains silver and iron mineralised by arsenic; the arsenic in a larger proportion than the iron. This is the *Pyrites argenteus* of Henckel.

1. It is a hard substance, of a white shining appearance, and of a compact, lamellar, or fibrous texture. (*Kirwan*, sp. 7.)
2. Of a yellowish white colour, and of a striated structure, resembling bismuth, but much harder. (*Kirwan*, sp. 3.)—It is found near Guadanal canal in Spain.
3. Near the same place is found also another ore of the same kind, which is very soft and easily cut; and when cut, has a brilliant metallic appearance. It consists of conchoidal laminæ. The quintal contains only from four to six ounces of silver; but it is easily reduced by evaporating the arsenic, which then leaves the silver slightly contaminated with iron. (*Kirwan*, sp. 4.)

(3.) With

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dissolve it in its metallic state, (*Bergman.*) However, the marine acid, if well concentrated, or rather reduced into an aerial form, dissolves silver in its metallic state, (*Fabroni.*)

Mr Scheele, and after him Mr Bertholet, assert positively, that the marine acid, being dephlogisticated by its distillation over maganese in the form of a yellow air or gas, dissolves all the metals, without excepting gold, silver, or mercury. See Scheele's Essay 5. § 25. H.

The vitriolic acid being distilled also over the maganese, dissolves silver, gold, and mercury, as Dr Crell asserts, (*Journal de Physique*, Oct. 1785, p. 297.)

Silver is precipitated from the vitriolic and nitrous acids by the marine; and from the nitrous, in great measure, by the vitriolic, (*Kirwan.*)

(q.) Wallerius distinguishes seven species of silver: (see the article Silver). Daubenton reckons eight varieties of *native white silver*, arising from their peculiar forms.

(3.) With sulphur and arsenic. The red or ruby-like silver ore. The *rothgulden* of the Germans.

The colour of this ore varies as the proportion of the ingredients varies in the mixture, viz. from dark grey to deep red; but when it is rubbed or pounded, it always gives a red colour.

a. Grey arsenical silver ore.

1. Plated, crusted, or leaved.
2. Solid.

b. The red arsenical silver ore:

1. Plated, crusted, or leaved;
2. Solid or scaly.
3. Crystallised (R.)

In this last form it shows the most beautiful red colour, and is often semi-transparent. It contains about 60 *per cent.* in silver.

(4.) With sulphur, little arsenic, and iron.—(*Schwartz ertz, Schwartz gulden, Silber mulm.* Germ.)

This is a friable, weathered, decayed ore.

a. Of a black or footy colour; and is therefore called by the Germans *silberschwartz*, or *russigtes-ertz*.

(5.) With sulphurated arsenic and copper. The *weissgulden* of the Germans.

This, in its solid form, is of a light grey colour, and of a dull and steel-grained texture. Its proportion of silver is from 10 to 30 *per cent.*

(6.) With sulphurated arsenic and iron. The *weisertz*, or white silver ore of the Germans.

This is an arsenical pyrites, which contains silver; it occurs in the Saxon mines, and so exactly resembles the common arsenical pyrites, as not to be distinguished from it by sight alone, or without other means.

(7.) With sulphurated antimony.

a. Of a dark grey and somewhat brownish colour; the *laberetz* of the Germans.

b. Of a blackish blue colour.

1. In form of capillary crystals. *Federertz*, or plumose silver ore.

(8.) With iron, arsenic, and cobalt, mineralised by sulphur.

This ore looks like the *weissgulden* described above; but is distinguished by the rose coloured particles of cobalt, dispersed through dark brown, blackish, or grey, and sometimes shining solid mass. It is to this species of ores that the silver goose dung ore belongs.

(9.) With sulphurated copper and antimony.—The Dal *fah-lertz*.

This resembles both in colour and texture the dark-coloured weissgulden. When rubbed, it gives a red powder.

a. Solid.

b. Crystallised.

(10.) With sulphurated zinc. The *pechblende* of the Germans.

This is a zinc ore, mock lead, or blende, which contains silver, and is found among rich silver and gold ores.

a. Of a metallic changeable colour.

1. Solid, and with fine scales.
2. In form of balls. The *kugel-ertz*, or ball ore.

b. Black mock lead, or blende, found in Saxony. This is also found,

1. Solid, and with fine scales;
2. And in form of balls.

(11.) With sulphurated lead; potters ore. *Galena; bleyglanz.*

(12.) With sulphurated lead and antimony, called *striperz*.

(13.) With sulphurated iron. *Silberhalitgier kies*; marcasite holding silver.

(14.) With sulphurated and arsenical cobalt; dendrites being sometimes found in the stone.

These kinds keep well in water; but generally wither in the air, and lose the silver they contain.

(15.) Mineralized by sulphur, with regulus of antimony and barytes. The butter-milk ore.

This is found in the form of thin particles, on granular spar, (*Kirwan*, sp. 13.)

(16.) Combustible silver ore.

This is a black and brittle substance, and leave about 6 per cent. of silver in its ashes. It is in fact a coal in which silver is found. (*Kirwan*, sp. 14.)

(17.) With the acid of common salt. *Minera argenti cornea. Hornetz*, or horn-silver ore.

This is the scarcest silver ore; it is of a white or pearl colour, changeable or varying on the surface, semi-transparent, and somewhat ductile both when crude and when melted. It cannot be decomposed without some admixture of such substances as attract the acid of sea-salt.

III. Platina del Pinto; *Juan blanca*.

This metal is a recent discovery of our times; and is described with great accuracy by Scheffer, in the Acts of the Royal Academy of Sciences at Stockholm for the year 1752; as also by Dr Lewis, in the Philosophical Transactions for the year 1754, vol. xlviii. and by many other writers. By these descriptions we are convinced of the resemblance this metal bears to gold; and therefore we must allow it to be called *white gold*. It has, however, a variety of distinguishing qualities

(R) Wallerius mentions the six following varieties of this notable ore in his *Species* 388, viz. 1. The red opaque, like cinnabar, from Andreasberg in the Hartz, and from Salberg in Westmannia: 2. The bluish, from Freiberg and Annaberg: 3. The grey, from Freiberg and Andreasberg: 4. The red transparent amorphous, of the garnet colour, from Potosi and Ioachimstal: 5. The red transparent, crystallised into prismatic decaedres, or dodecaedres, from Hungary, Alsace, and the Duchy of Deuxponts: 6. The only superficially red ore, from Salberg and Ehrenfriederichsdorf.

Perfect Metals. *Quickfilver.*

lities befides its colour, which afcertain its peculiar nature : All which, with its hiftory, ufes, &c. are particularly defcribed under the detached article PLATINA. See alfo CHEMISTRY-*Index;* and METALLURGY, Part II. fect. ii.

1. It is of a white colour.
2. It is fo refractory in the fire, that there is no degree of heat yet found by which it can be brought into fufion by itfelf, the burning-glafs excepted. But, when mixed with other metals and femimetals, it melts very eafily, and efpecially with arfenic, both in its metallic form and in form of a calx or glafs.

IV. Quickfilver, mercury. *Hydrargyrum, Argentum vivum, Mercurius.* See the article QUICKSILVER; CHEMISTRY-*Index,* at *Mercury;* and METALLURGY, Part II. fect. viii.

Mercury diftinguifhes itfelf from all metals by the following qualities (S.)

a. Its colour is white and fhining, a little darker than that of filver.

b. It is fluid in the cold, and divifible by the leaft force; but, as it only fticks to a few bodies to which it has an attraction, it is faid that it does not wet.

c. It is volatile in the fire.

d. It attracts the other femimetals and metals; and unites with them all except cobalt and nickel, with which it cannot by any means yet known be made to mix. This union is called *amalgamation.* This amalgamation, or mixtion of metallic bodies, according to the readinefs with which they unite or mix, is in the following progreffion, viz. gold, filver, lead, tin, zink, bifmuth, copper, iron, and the regulus of antimony; the three latter, however, do not very readily amalgamate. The iron requires a folution of the vitriol of iron, as a medium to promote the union.

e. It diffolves in fpirit of nitre, out of which it is precipitated by a volatile alkali, and common falt, in form of a white powder; but if a fixed alkali is ufed, a yellow powder or calx is obtained (T).

f. But

(S) It were almoft fuperfluous, fays Mr Kirwan, to mention any other character of quickfilver than its liquidity, to diftinguifh it from other metals. In regard to this property, Bergman obferves, that mercury conftitutes one extreme among the metals, and platina the other; fince it requires to be melted only fuch a degree of heat as is rarely wanting in our atmofphere, and boils at the 6000 degrees nearly after lead melts. See the table at p. 111. *Note.* But when the cold is increafed to the temperature denoted by 40 degrees below 0 both of Fahrenheit's and of the Swedifh thermometer, which both coincide in that point (fince 212—32, or 180 : 100 : : 32+40, or 72 : 40), this metal concretes like any other metal, and becomes quite folid; (fee Philofophical Tranfactions for 1783, p. 303.) Mercury in its common ftate, therefore, according to Bergman (Treatife of *Elect. Attract.*), is to be confidered as a metal in fufion : and fince in its folid ftate it is nearly as malleable as lead, it by no means ought to be placed among the femimetals, otherwife every other entire metal fhould be confidered as brittle, for none is malleable when in fufion.

(T) 1. Mercury is diffolved with great rapidity by nitrous acid : the liquor is of a greenifh-blue colour, but lofes it afterwards and becomes limpid. This folution, when made without heat, is ufed as a teft for the analyfis of mineral waters, and has different properties from that made with the help of heat. In the firft cafe, fays Bergman, very little phlogifton is loft, and the falt eafily cryftallifes, being white, and fcarcely acrid. It is not precipitated by diftilled water; but by cauftic vegetable alkali, it is precipitated of a yellowifh colour; by mild alkali, the precipitation is white; by mineral alkali, it is yellow, but it foon grows alfo white; by volatile alkali, it turns to a greyifh-black colour; by Glauber's falt, or by pure vitriolic acid, the precipitation is white, granulated, and in a fmall quantity; nor, if this precipitant has been fparingly ufed, does this colour appear in lefs than an hour : by muriatic acid, or common falt, the precipitation is alfo white, but in a large quantity, and in curdles.

2. But if the mercurial folution be put over a fand-heat, it may be charged with a quantity of mercury equal almoft to its weight. According to the chemifts of Dijon, 10 ounces of nitrous acid may diffolve eight of mercury. The action of the folvent becomes ftronger with the heat; emits great quantity of vapours; and if not taken from the fire, will be too far evaporated. Diftilled water will precipitate from this folution a white calx, becaufe it is more dephlogifticated, and the folvent is overcharged with it; and the water changing the denfity of the liquor, diminifhes the adhefion of the calx, as Fourcroy remarks. This white calx will turn yellow, if boiling water be poured on it. The vegetable alkali precipitates it of a brownifh yellow, which by degrees affumes a pale-yellow tinge : the mild vegetable, and the mineral alkalies, produce nearly the fame colour; though when this laft is employed, the colour turns afterwards to white. The precipitation by volatile alkali is quite white alfo; that by the vitriolic acid is yellow; and, finally, a copious white mucilaginous matter is the precipitate by the marine acid.

3. This folution by nitrous acid is very cauftic; corrodes and deftroys animal fubftances; when it falls on the fkin, ftains it it of a deep purple brown colour, which appears black : the ftains do not go off before the feparation of the epidermis, which falls away in fcales or kind of fcars. It is ufed in furgery as a powerful efcharotic, and is called *mercurial water.*

4. The fame folution, by cooling, is fufceptible of forming cryftals, which vary from one another according to circumftances: for the moft part they are like needles; are very cauftic; redden the fkin; and detonate when put on burning coals, provided they be dry. They are called *mercurial nitre,* which fufes when heated in a crucible; exhales reddifh fumes; affumes a deep yellow colour, which afterwards turns to orange, and

f. But it requires a boiling heat to diffolve it in oil of vitriol (u).

g. It is not affected by the acid of common falt, unlefs it be previoufly diffolved by other acids (v); in which cafe only they both unite with one another, and may be fublimed together; this fublimate is a ftrong poifon.

h. It unites with fulphur by grinding; and then produces a black powder called *æthiops mineralis* (w), which fublimes into a red ftriated body called *factitious cinnabar*.

i. The fulphur is again feparated from the quickfilver, by adding iron or lime, to which the fulphur attaches itfelf, leaving the quickfilver to be diftilled over in a metallic form; but if a fixed alkali be ufed, fome part of the quickfilver will remain diffolved in the refiduum, which is a liver of fulphur.

Quickfilver is found,

A. Native, or in a metallic ftate. *Mercurius nativus*, or *virgineous*.

This found in the quickfilver mines at Idra in Friuli, or the Lower Auftria, in clay, or in a black flaty *lapis ollaris*, out of which it runs, either fpontaneoufly, or by being warmed even in the hands.

B. United to gold or filver. *Hydrargyrum argento vel auro adunatum.*

Mr Kirwan afferts, on the authorities of Monet and Lin. Von Gmelin, that in Sweden and Germany mercury has been found united to filver in the form of a fomewhat hard and brittle amalgam.

Romé de l'Ifle had a fpecimen of this natural amalgam from Germany, which is imbedded in a quartzofe mafs, and mixed with cinnabar, as Mr Mongez afferts; and he adds, that in the royal cabinet, at the king's garden at Paris, is depofited another fine fpecimen of this mercurial ore, which was found cryftallifed in the mine called *Carolina* at Muchel-lanfberg in the duchy of Deux Ponts. M. de l'Ifle fpeaks alfo very pofitively of a fpecimen of native gold from Hungary, which feems to be a natural amalgam of gold and mercury. It is compofed of quadrangular prifms, of a greyifh yellow colour, and of a brittle texture. This fpecimen is alfo in the king's cabinet at the royal garden at Paris.

Mr Kirwan, fpeaking of the method of examining the purity of gold by the moift way, fuppofes, with Sir Torbern Bergman, that there are natural amalgamations of mercury with gold and filver: and Neumann obferves, that fometimes a mineral, containing gold or filver, is met with among mercurial ores, although this is a great rarity.

It is evident, therefore, that there naturally exift

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and at laft to a brilliant red: in this ftate it is called *red precipitate*, or *arcanum corallinum*. It muft be made in a matrafs with a gentle heat if it is defigned to be corrofive for chirurgical purpofes.

(u) 1. The vitriolic acid, concentrated and boiling hot, feizes on mercury, and prefently reduces it if urged by heat to a kind of white powder, which turns yellow by the affufion of hot water, but does not diffolve in it; this is called *turbith mineral*: but if cold water, inftead of hot, was poured in the white mafs, the powder would not change its white colour into yellow as was faid above about the nitrous folution.

2. If Mercury be rarefied by heat into vapours, and thefe meet with thofe of marine acid in the fame ftate, a corrofive fublimate will be formed. This metallic falt fhoots into cryftals pointed like daggers, which are the ftrongeft of all poifons. But there are various other proceffes found in chemical authors to make this falt with more or lefs trouble. See Chemistry, n° 814—818.

3. If corrofive fublimate be mixed with tin and diftilled, a very fmoking liquor is produced, called by the name of its inventor the *fmoking liquor of Libavius*. See Chemistry, n° 810.

The muriatic acid in the fublimate is not faturated, and from hence proceeds its great corrofive power; for if a frefh quantity of mercury be added to it, and fublimed a fecond or third time, a fweet, or mixed fublimate, called *mercurius dulcis*, is produced, which is not poifonous, and is given internally as a purgative, or an emetic, according to the dofe. See Chemistry, n° 819.

(v) Muriatic acid does not act upon quickfilver unlefs this laft be previoufly deprived of as much phlogifton, as $\frac{24}{100}$ of the quantity contained in the hundred of filver, or of $\frac{30}{181}$ in the hundred of zinc. (See Bergman's *Sciagraphia*, and his treatife *De Phlogifti quantitate*.)

(w) The academicians of Dijon fay, that the true proportion to make this æthiops, is that of one part of brimftone with four of mercury. Fourcroy directs only one of mercury, with three of flowers of fulphur, to be triturated, till the mercury is extinguifhed. A black powder is then produced, which is the æthiops mineral. The combination is better effected when the mercury is mixed with the fufed fulphur: by agitating this mixture, it becomes black, and eafily takes fire; it fhould be then taken from the fire, and the flame fhould be extinguifhed a little after, ftirring the mafs till it becomes into folid clots. If this fubftance be expofed to a great degree of heat, it takes fire, the fulphur is confumed, and a fubftance remains which is of a violet colour when pulverifed. This powder being put into matraffes, till their bottom become red by the force of fire, is fublimed after fome hours, and artificial cinnabar is found in the top of the veffels cryftallifed into brown red needles.

Mercury, divided by means of a rapid and continual motion, as that of a mill-wheel, gradually changes itfelf into a very fine black powder, which is called *æthiops per fe*, on account of its colour, in order to diftinguifh it from this *æthiops mineralis* mentioned in the text.

Perfect Metals. *Quickfilver.*

ift various ores of quickfilver, amalgamated with filver, gold, and other minerals, although they be but feldom met with.

C. Mineralifed,

[1.] With fulphur.

A. Pure cinnabar, *Cinnabaris nativa.*

a. Loofe or friable cinnabar like red ochre.

b. Indurated or folid cinnabar. It is of a deep red colour; and, with refpect to its texture, is either,

1. Steel-grained;
2. Radiated;
3. Compofed of fmall cubes, or fcaly; or
4. Cryftallifed, in a cubical form; it is tranfparent, and deep red like a ruby.

B. Impure cinnabars.

1.) A mercurial ore is found in Idria, fays Gellert, where the mercury lies in an earth or ftone, as if it were in a dead form; and has the appearance of a red-brown iron-ftone; but it is much heavier than that. It contains from three quarters to feven eighths of the pureft mercury; leaves, after diftillation, a very black ftrong earth behind; and gives fome marks of cinnabar.

2.) Liver ore, which is moft common in Idria, and has its name from its colour.—Outwardly it refembles an indurated iron-clay; but its weight difcovers that its contents are metallic. It yields fometimes 80 pounds of quickfilver per hundred weight.

3.) Burning ore; *brand-erz* in German. This ore may be lighted at the candle; and yields from nine to 50 pounds of quickfilver per hundred weight. *Brunnich.*

[2.] With iron by fulphur. Pyritous cinnabar. Sir Torbern Bergman inferted this ore in the 177th fection of his *Sciagraphia*, and feems doubtful whether this be a diftinct fpecies from the cinnabar; as the iron is perhaps, fays he, only mechanically diffufed therein. Mr Mongez remarks, that there are but a few inftances of cinnabar in which iron is not found in its calcined form; though, in the act of the ore being reduced, it paffes to its metallic ftate, and becomes capable of being acted on by the loadftone.

Another pyritous ore of cinnabar was found at Menidot, near St Lo in Lower Normandy. It confifted in grains of different fizes, of a red brown colour: they had a vitriolic tafte and fulphureous fmell. Found alfo at Almaden in Spain, and at Stahlberg in the Palatinate; though at this laft place they are of a dodecaedral form.

[3.] With filver by the aerial acid, and fulphur.

This feems to be a native precipitate *per fe*, or calx of mercury. It is faid to have been lately found in Idria, in hard compact maffes of a brownifh-red colour; fee *Journal de Phyfique* for January 1784, p. 61. If this account can be relied upon, it will prove, that quickfilver, even in a calciform ftate, is naturally found mineralifed with filver by means of fulphur.

[4.] With fulphur and copper.

This ore is blackifh grey, of a glaffy texture, and brittle; crackles and fplits exceffively in the fire; and when the quickfilver and fulphur are evaporated, the copper is difcovered by its common opaque red colour in the glafs of borax, which, when farther forced in the fire, or diluted, becomes green and tranfparent. It is found at Mufchlanfberg in the duchy of Deux Ponts.

[5.] Mineralifed by the marine and vitriolic acids.

Mineralogy owes the difcovery of this ore to Mr Woulfe, who publifhed an account of it in the Philofophical Tranfactions for 1776. It was found in the duchy of Deux Ponts, at the mine diftinguifhed by the name of *Obermofchal*. It had a fpar-like appearance. This ore is either bright and white, or yellow or black. It was mixed with cinnabar in a ftony matrix: and being well mixed with one-third of its weight of vegetable alkali, afforded cubic and octagonal cryftals; that is, falt of Sylvius and vitriolated tartar.

The marine falt of this mercury is in the ftate of fublimate corrofive.

Order II. Imperfect or base Metals.

Imperfect Metals. *Tin.*

I. Tin. *Stannum; Jupiter.* (See the detached article Tin: Alfo Chemistry-*Index*; and Metallurgy, Part II. fect. vi. and Part III. fect. vi.)

This is diftinguifhed from the other metals by the following characters and qualities. It is,

a. Of a white colour, which verges more to the blue than that of filver.

b. It is the moft fufible of all metals; and,

c. The leaft ductile; that is, it cannot be extended or hammered out fo much as the others (x).

d. In

(x) Tin is fufficiently ductile to be beaten into very thin leaves. But ductility and extenfibility are two different properties, lefs connected with one another than is generally imagined. Iron and fteel are drawn into exquifite fine wire, but cannot be beat into very thin leaves. Tin, on the other hand, is beat into fine leaves, and may be exended between rollers to a confiderable furface. The tin-fheet ufed in various arts, is commonly about $\frac{1}{300}$th part of an inch; but may be extended twice as much in its dimenfions without difficulty. Notwithftanding this extenfibility, tin cannot be drawn into wire, on account of the weak cohefion of its particles. A tin wire, however, of one-tenth of an inch diameter, is able to fupport a weight of $49\frac{1}{2}$ pounds, according to Fourcroy. Gold and filver poffefs both properties of ductility and extenfibility the moft eminently of all metallic bodies; whilft lead, notwithftanding its flexibility and foftnefs, cannot be made either into leaves or wire of any finenefs.

d. In breaking or bending, it makes a crackling noise.

e. It has a smell particular to itself, and which cannot be described.

f. In the fire it is easily calcined to white ashes, which are 25 per cent. heavier than the metal itself. During this operation, the phlogiston is seen to burn off in form of small sparkles among the ashes or calx.

g. This calx is very refractory; but may, however, with a very strong degree of heat be brought to a glass of the colour of colophony. But this calx is easily mixed in glass compositions, and makes with them the white enamel.

h. It unites with all metals and semimetals; but renders most of them very brittle, except lead, bismuth, and zinc.

i. It amalgamates easily with quicksilver.

k. It dissolves in aqua-regia, the spirit of sea-salt, and the vitriolic acid; but is only corroded into a white powder by the spirit of nitre. The vegetable acid, soaps, and pure alkaline salts, also corrode this metal by degrees.

l. Its specific gravity to water is as 7400 to 1000, or as 7321 to 1000.

m. Dissolved in aqua-regia, which for this purpose ought to consist of equal parts of the spirit of nitre and sea-salt, it heightens the colour of the cochineal, and makes it deeper; for otherwise that dye would be violet.

(1.) Native Tin.

The existence of native tin has long been questioned: but it has undoubtedly been found some years ago in Cornwall, as Mr Kirwan remarks.

1. Malleable tin, in a granular form, and also in a foliaceous shape, issuing out of a white hard matter like quartz: but which, after being properly assayed, proved to be arsenical crystals; a circumstance that evinces its being native tin, since the arsenic could not remain in this form if the tin had been melted. It appeared like a thick, jagged, or scolloped lace or edging; and was found near St Austle in Cornwall.

2. In the form of crystalline metallic laminæ, or laminated crystals, rising side by side out of an edging, which shone like melted tin: they were almost as thin as flakes or scales of talc, interfecting each other in various directions, with some cavities between them, within which appeared many specks and granules of tin, that could be easily cut with a knife: this was also found in Cornwall.

3. In a massy form, more than one inch thick in some places, and inclosed in a kind of quartzous stone; or rather in an hard crust of crystallised arsenic.

(2.) Calciform Ores of Tin.

A. In form of a calx, *Stannum calciforme*.

A. Indurated, or vitrified.

1. Mixed with a small portion of the calx of arsenic.

a. Solid tin ore, without any determinate figure. Tin-stone.

It resembles a garnet of a blackish brown colour, but is much heavier; and has been considered at the English tin-mines as a stone containing no metal, until some years ago it began to be smelted to great advantage.

B. Crystallised.

a. Tin spar, or white tin ore. This is generally of a whitish or grey colour; sometimes it is yellowish, semi-transparent, and crystallised, either of a pyramidical form, or irregularly.

b. Tin-grains. This ore, like the garnets, is of a spherical polygonal figure; but seems more unctuous on its surface.

1. In large grains.

2. In small grains.

B. Mixed with metals.

1. With the calx of iron, as in the garnet.

2. With manganese. See the *Semimetals*.

C. Mineralised.

1. With sulphur and iron.

2. With sulphur. *Aurum musivum*.

This was discovered by Professor Bergman, among some minerals which he received from Siberia. He observed two sorts of it, analogous to the two artificial combinations of tin with sulphur.

1. One nearly of the colour of zinc, and of a fibrous texture, which contained about 20 *per cent*. of sulphur, and the remainder tin.

2. The other enveloped the former like a crust; resembled aurum musivum; and contained about 40 *per cent* of sulphur, a small proportion of copper, and the remainder tin. *Mem. Stockh*. for 1721, p. 328.

At Huel Rock, in St Agnes in Cornwall, there has been found a metallic vein, nine feet wide, at 20 yards beneath the surface. Mr Raspe was the first who discovered this to be a sulphurated tin-ore: it is very compact, of a bluish white colour, approaching to grey steel, and similar to the colour of grey copper ore: it is lamellar in its texture, and very brittle. It consists of sulphur, tin, copper, and some iron. Mr Raspe proposes to call it *bell-metal ore*.

According to Mr Klaproth's analysis of this ore, 119 grains contain 30 of pure sulphur; 41 of tin; 43 of copper; two of iron; and three grains of the stony matrix. In another specimen of the same sulphurated tin-ore from Cornwall, there were in the hundred 25 parts of sulphur, 34 of tin, 36 of copper, three of iron, and two of the stony matrix.

II. Lead; *Plumbum, Saturnus*. (See the article Lead, and Chemistry-*Index*: Also Metallurgy, Part II. sect. v. and Part III. sect. vii.)

The properties of lead are as follows.

a. It is of a bluifh white colour when frefh broke, but foon dulls or fullies in the air.

b. It is very heavy; viz. to water as 11,325 to 1000.

c. It is the fofteft metal next to gold; but it has no great tenacity, and is not in the leaft fonorous.

d. It is eafily calcined; and, by a certain art in managing the degrees of the fire, its calx becomes white, yellow, and red.

e. This calx melts eafier than any other metallic calx to a glafs, which becomes of a yellow colour, and femitranfparent. This glafs brings other bodies, and the imperfect metals, into fufion with it.

f. It diffolves, 1ft, In the fpirit of nitre; 2dly, In a diluted oil of vitriol, by way of digeftion; 3dly, In the vegetable acid; 4thly, In alkaline folutions; and 5thly, In expreffed oils, both in the form of metal and of calx.

g. It gives a fweet tafte to all folutions.

h. It amalgamates with quickfilver.

i. With the fpirit of fea-falt it has the fame effect as filver, whereby is produced a *faturnus corneus*.

k. It does not unite with iron, when it is alone added to it in the fire.

l. It works on the cupel, which fignifies that its glafs enters into certain porous bodies, deftitute of phlogifton and alkaline falts.

m. It melts in the fire before it is made red-hot, almoft as eafily as the tin.

n. Its calx or glafs may be reduced to its metallic ftate by pot-afhes.

[1.] Native Lead.

For proofs of lead being naturally found in its metallic ftate, fee the article Lead.—It may be here added, that Henckel likewife affirms its exiftence, in his *Flora Saturnifans*; (fee Kirwan's *Elements of Mineralogy*, p. 297, 298.) Wallerius afferts, that it has been fo found in Poland, a fpecimen of which was kept in the collection of Richter; and adds, that a fimilar one found at Schneberg, was feen in the collection of Spener. (*Mineralogy*, vol. ii. p. 301.)

Dr Lawfon, in his Englifh edition of Cramer's Art of Effaying Metals, fays, that fome pure native malleable lead had been lately found in New England; (p. 147.) And laftly, Profeffor Bergman did not hefitate to infert, by itfelf alone, the *plumbum nativum*, in Sect. 180. of his *Sciagraphia*.

[2.] Calciform Lead.

Lead is found,

A. In the form of a calx.

A. Pure.

a. Friable lead ochre, native cerufe.

b. Indurated lead fpar, or fpatofe lead ore.

i. Radiated, or fibrous.

1. White, from Mendip-hills, in England.

ii. Cryftallifed in a prifmatic figure.

1. White, from Norrgrufva in Weftmanland.

2. Yellowifh green, from Zchopau in Saxony.

B. Mixed,

1. With the calx of arfenic, arfenical lead fpar.

2. Indurated.

a. White. Mr Cronftedt has tried fuch an ore from an unknown place in Germany, and found that no metallic lead could be melted from it by means of the blow-pipe, as can be done out of other lead fpars; but it muft be performed in a crucible. (See the article Lead. par. iii.)

3. With a calcareous earth.

This ore effervefces with aqua-fortis, and contains 40 *per cent.* of lead; on which account is is placed here rather than among the calcareous earths.

B. Mineralifed.

1. With fulphur alone: the *bley-fchweiff*, or *bley-glanz*, of the Germans.

a. Steel-grained lead-ore.

b. Radiated, or antimoniated lead-ore.

c. Teffellated, or potter's lead-ore.

At Villach in Auftria there is faid to be found a potter's lead-ore, which contains not the leaft portion of filver.

2. Mineralifed by the vitriolic acid.

This ore was difcovered by Mr Monnet. It occurs fometimes, though rarely, in the form of a white ponderous calx; and feems to originate from the fpontaneous decompofition of the fulphurated lead-ores above mentioned.

3. By the acid of phofphorus.

This ore was lately difcovered by Gahn; and is of a greenifh colour, by reafon of a mixture of iron. See the article Lead, par. 6.

4. With fulphurated filver. *Galena*; alfo called *bleyglanz* by the Germans. Potter's ore.

a. Steel-grained.

b. With fmall fcales.

c. Fine-grained.

d. Of a fine cubical texture; and,

e. Of coarfe cubes. Thefe two varieties are found in all the Swedifh filver-mines.

f. Cryftallifed.

The fteel-grained and fcaly ores are of a dim and dull appearance when they are broken, and their particles have no determined angular figure: they are therefore in Swedifh commonly called *blyfchweif*; in oppofition to the cubical ores, which are called *blyglanz*. The moft part of the ores called *blyglanz* contain filver, even to 24 ounces *per cent.* of which we have inftances in the mines of Salberg, where it has been obferved, that the coarfe cubical lead ores are generally the richeft in filver, contrary to what is commonly taught in books; the reafon of which may perhaps be, that, in making the effays on thefe two ores, the coarfe cubical can be chofen purer or freer

Imperfect Metals. *Lead.*

freer from the rock than the fine cubical ores.

5. With fulphurated iron and filver. This is found,

a. Fine-grained. *b.* Fine cubical. *c.* Coarfe-cubical. When this ore is fcorified, it yields a black flag; whereas the preceding lead-ores yield a yellow one, becaufe they do not contain any iron.

6. With fulphurated antimony and filver; antimoniated or radiated lead-ore. This has the colour of a blyglanz, but is of a radiated texture.

It is found,

a. Of fine rays and fibres; and,

b. Of coarfe rays or fibres. The lead in this ore prevents any ufe being made of the antimony to advantage; and the antimony likewife in a great meafure hinders the extracting of the filver.

7. Mineralifed by arfenic.

This ore was lately difcovered in Siberia.—Externally it is of a pale, and internally of a deep red, colour. See the article Lead, par. 10.

C. Mixed with earth; ftony, or fandy lead ores.

Thefe confift either of the calciform or of the galena kind, intimately mixed and diffufed through ftones and earth, chiefly of the calcareous or of the barytic genus. See Lead, par. 11.

Ufes, &c. *of Lead.* See Lead, and the other articles above referred to.

III. Copper; *Cuprum, Venus, Æs.* (See the article Copper: Alfo Chemistry-*Index;* and Metallurgy, Part II. fect. iv. and Part III. fect. iv.)

This metal is,

a. Of a red colour.

b. It is pretty foft and tough.

c. The calx of copper being diffolved by acids becomes green, and by alkalies blue.

d. It is eafily calcined in the fire into a blackifh blue fubftance, which, when rubbed to a fine powder, is red; when melted together with glafs, it tinges it firft reddifh brown, and afterwards of a tranfparent green or fea-green colour.

e. It diffolves in all the acids, and likewife in alkaline folutions. It is eafier diffolved when in form of a calx than in a metallic ftate, efpecially by the acids of vitriol and fea-falt, and the vegetable acid.

f. Vitriol of copper is of a deep blue colour; but the vegetable acid produces with the copper a green falt, which is verdigris.

g. It can be precipitated out of the folutions in a metallic ftate; and this is the origin of the precipitated copper of the mines called *Ziment copper.*

h. It is not eafily amalgamated with quickfilver; but requires for this purpofe a very ftrong trituration, or the admixture of the acid of nitre.

i. It becomes yellow when mixed with zinc, which has a ftrong attraction to it, and makes brafs, pinchbeck, &c.

Imperfect Metals. *Copper.*

k. When this metal is expofed to the fire, it gives a green colour to the flame in the moment it begins to melt, and continues to do fo afterwards, without lofing any thing confiderable of its weight.

[1.] Native copper.

Copper found naturally in a metallic ftate, is called *virgin* or *native copper.* It is met with,

1. Solid.

2. Friable, in form of fmall, and fomewhat coherent grains. Precipitated or ziment copper.

[2.] Calciform.

Copper, in form of a calx, is found,

1.) Pure.

A. Loofe or friable; *Ochra veneris.*

1. Blue; *Cæruleum montanum.* Very feldom found perfectly free from a calcareous fubftance.

2. Green; *Viride montanum.* Both this and the former colour depend on menftrua, which often are edulcorated or wafhed away.

3. Red. This is an efflorefcence of the glafs copper ore.

B. Indurated. Glafs copper-ore.

a. Red. This is fometimes as red as fealing wax, and fometimes of a more liver-brown colour.

It is always found along with native copper, and feems to have loft its phlogifton by way of efflorefcence, and to be changed into this form. It is likewife found with the fulphurated copper, improperly called *glafs copper-ore.*

2.) Mixed.

A. Loofe or friable; *Ochra veneris friabilis impura.*

1. Mixed with a calcareous fubftance; *Cæruleum montanum.* In this ftate copper-blue is moftly found. It ferments during the folution in aquafortis.

2. Mixed with iron. Black. It is the decompofition of the Fahlun copper ore.

B. Indurated.

1. Mixed with gypfum, or plafter. Green.

2. Mixed with quartz. *a.* Red, from Sunnerfkog in the province of Smoland.

3. Mixed with lime. *a.* Blue. This is the *Lapis Armenus,* according to the accounts given of it by authors.

3.) Cupreous ftones.

Analogous to the calciform copper ores, are,

1. The *lapis armenus.* } See the detached article Copper, n° 7.
2. The turquoife. }

[3.] Diffolved and mineralifed; *Cuprum mineralifatum.*

A. With fulphur alone. Grey copper-ore; alfo called, improperly, *glafs copper-ore.*

a. Solid, without any certain texture, and very foft, fo that it can be cut with a knife almoft as eafily as black lead.

b. Fine cubical. In Smoland this is fometimes

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times found decompofed or weathered, and changed into a deep mountain blue.

B. With fulphurated iron. *Minera cupri pyritacea*; yellow copper ore. Marcafitical copper ore; *Pyrites cupri*. This is various both in regard to colour and in regard to the different proportion of each of the contained metals; for inftance,

a. Blackifh grey, inclining a little to yellow; *Pyrites cupri grifeus*. When decayed or weathered, it is of a black colour; is the richeft of all the varieties of this kind of copper ore, yielding between 50 and 60 *per cent*. and is found in Spain and Germany.

b. Reddifh yellow, or liver brown, with a blue coat on the furface; *Minera cupri lazurea*. This ore yields between 40 and 50 *per cent*. of copper, and is commonly faid to be blue, though it is as red, when frefh broken, as a red copper regulus.

c. Yellowifh green; *Pyrites cupri flavo viridefcens*. This is the moft common in the north part of Europe: and is, in regard to its texture, found,

1. Solid, and of a fhining texture.
2. Steel-grained, of a dim texture.
3. Coarfe-grained, of an uneven and fhining texture.
4. Cryftallifed marcafitical copper ore.
   a. Of long octoëdrical cryftals.

d. Pale yellow. This cannot be defcribed but as a marcafite, though an experienced eye will eafily difcover fome difference between them. It yields 22 *per cent*. of copper.

e. Liver-coloured.

C. With fulphurated filver, arfenic, and fome iron. Fallow copper-ore; which contains only a few ounces of filver. This ore is found in Hungary and Germany, where it is called *black copper ore*.

D. With fulphurated arfenic and iron. White copper ore.

E. Pyritous copper, with arfenic and zinc.
According to Mr Monnet, this ore is found at Catharineberg in Bohemia. It is of a brown colour; of a hard, folid, compact, granular texture; and contains from 18 to 30 *per cent*. of copper.

F. Diffolved by the vitriolic acid; *Vitriolum veneris*. See the article copper, n° xiii.

G. With phlogifton. Copper coal ore, confifting of the calces of copper, mixed with a bituminous earth.

H. Mineralifed by the muriatic acid. This ore was found in Saxony, and had been generally miftaken for a micaceous fubftance, which in fact it greatly refembles. It has not yet been found in large maffes, but only in a fuperficial form, like a cruft over other ores. It is moderately hard and friable; of a fine green colour, and fometimes of a bluifh green, cryftallifed in a cubic form, or with a foliated texture, or in little fcales refembling green mica or talc. This ore is eafily diffolved by nitrous acid: the folution takes a green colour; and the metal may be precipitated on a polifhed plate of iron. If fome drops of a nitrous folution of filver be mixed with it, a white powder of *luna cornea* will be precipitated, which difcovers the prefence of the muriatic acid in this ore.

The ufes of copper are very numerous, although not thoroughly known to every one. Several of thefe have been mentioned under the detached article, and in CHEMISTRY. Others of great importance may be here added. Its great ductility, lightnefs, ftrength, and durability, render it of very extenfive utility. Blocks, or bars of copper, are reduced into flat fheets of any thicknefs, by being firft heated by the reverberation of the flame, in a low-vaulted furnace, properly conftructed for the purpofe; and then immediately applied between large rollers of fteel, or rather of cafe-hardened iron, turned by a water-wheel or by the ftrength of horfes, fo that the hot metal is there quickly fqueezed; and the operation is repeated, bringing the rollers every time nearer to one another, till the metallic fheet acquires the intended thicknefs.

Thefe copper fheets are very advantageoufly employed in fheathing the bottoms of men of war and other veffels, which by this means are prevented from being attacked by the fea worms, and are kept clean from various marine concretions, fo as to fail with confiderably greater fwiftnefs. Copper fheets are alfo employed to cover the tops of buildings inftead of flates or earthen tiles, as is ufed in Sweden; and fome architects have begun to introduce the ufe of copper covering into Great Britain, which is much lighter, and may be ufed with great advantage, although it muft be much dearer in the prime coft.

Sundry preparations of copper are employed in painting, ftaining, and for colouring glafs and enamels. See GLASS and ENAMEL.

The folution of copper in aqua-fortis ftains marble and other ftones of a green colour; when precipitated with chalk or whiting, it yields the green and the blue verditer of the painters. According to Lewis, a folution of the fame metal in volatile fpirits ftains ivory and bones: when macerated for fome time in the liquor, they become of a fine blue colour, which, however, tarnifhes by expofure to the air, and becomes green afterwards.

The fame author prepared elegant blue glaffes, by melting common glafs, or powdered flint and fixed alkaline falt, with blue vitriol, and with an amalgam of copper; fine green ones were made with green verditer, and with blue verditer, as well as with the precipitate of copper made by fixed alkalies, and with a precipitate by zinc; and a reddifh glafs was produced by the calx and fcoria of copper made by fire alone. Even in this vitreous ftate, it feems as if a continuance of fire had the fame effect in regard to colour, as air has upon copper in other forms; as fome of the moft beautiful blue glaffes, by continued fufion, have changed

changed to a green colour. See farther the article Brass *in the Glass-trade*.

Verdegris is a preparation of copper diffolved by the vegetable acids, which act on this metal, diffolving it very flowly, but in confiderable quantities. It produces a fine green pigment for painting both in oil and water colours, inclining more or lefs to the bluifh according to circumftances.

So great is the tenacity of copper, that a wire of a tenth of an inch in diameter is capable of fupporting 299.5 pounds weight before it breaks.—Copper may be drawn into very fine wire, and beaten into extremely thin plates. The German artifts, chiefly thofe of Nurenberg and Aufburg, are faid to poffefs the beft method for giving to thefe thin plates of copper a fine yellow colour like that of gold. See the articles *Brass-Colour* and *Brass-Leaf.*

The parings or fhreds of thefe very thin leaves of yellow copper being well ground on a marble plate, are reduced to a powder fimilar to gold, which ferves to cover, by means of fome gum-water, or other adhefive fluid, the furface of various mouldings or other pieces of curious workmanfhip, giving them the appearance of real bronze, and even of fine gold, at a very trifling expence; becaufe the gold colour of this metallic powder may be eafily raifed and improved by ftirring it on a wide earthen bafon over a flow fire.

In fome of its ftates, copper is as difficultly extended under the hammer as iron, but proves fofter to the file, and never can be made hard enough to ftrike a fpark with flint or other ftones; from whence proceeds the ufe that is made of this metal for chifels, hammers, hoops, &c. in the gun-powder works.

The vitriolic acid does not act on copper unlefs concentrated and boiling: during this folution a great quantity of fulphureous gas flies off; afterwards a brown thickifh matter is found, which contains the calx of the metal partly combined with the acid. By folution and filtration, a blue folution is obtained, which being evaporated to a certain degree, produces after cooling long rhomboidal cryftals of a beautiful blue colour, called vitriol of copper; but if this folution be merely expofed a long time to the air, it affords cryftals, and a green calx is precipitated, a colour which all calces of this metal affume when dried by the air. Blue vitriol, however, is feldom formed by diffolving the metal directly in the vitriolic acid. That fold in the fhops is moftly obtained from copper pyrites. It may alfo be made by ftratifying copper-plates with fulphur, and cementing them together for fome time; becaufe the vitriolic acid of the fulphur being difengaged, attacks and corrodes the metal, forming a metallic falt, which by affufion of water yields perfect cryftals of blue vitriol. See Vitriol.

The nitrous acid, on the contrary, diffolves copper when cold with great rapidity; and a great quantity of fmoaking air or gas flies off, which, on being received in a pneumatic apparatus, and mixed in a glafs tube with atmofpheric air, fhows its good or bad quality for the refpiration of living animals, according as the common bulk is more or lefs diminifhed. This is one of the moft important of Dr Prieftley's difcoveries; and various inftruments known by the name of *eudiometers* have been fince invented for making thefe experiments with eafe and fatisfaction. See Eudiometer.

But the moft common ufe of copper is to make all forts of large ftills, boilers, pots, funnels, and other veffels employed by diftillers, dyers, chemifts, and various other manufacturers, who make ufe of large quantities of hot liquors in their various operations.

Although copper when pure is extremely valuable, on account of its ductility, lightnefs, and ftrength, it is, however, lefs ufeful on many occafions from the difficulty of forming large maffes of work, as it is not an eafy matter to caft copper folid, fo as to retain all its properties entire. For if the heat be not fufficiently great, the metal proves deficient in toughnefs when cold; and if the heat be raifed too high, or continued for a length of time, the copper blifters on the furface when caft in the moulds; fo that the limits of its fufion are very contracted. And from thefe circumftances pure copper is rendered lefs applicable to feveral purpofes.

We find, however, that the addition of a certain proportion of zinc removes almoft all thefe inconveniences, and furnifhes a mixed metal more fufible than copper, very ductile and tenacious when cold, which does not fo readily fcorify in a moderate heat, and which is lefs apt to ruft from the action of air and moifture.

Copper is the bafis of fundry compound metals for a great number of mechanical and œconomical ufes of life, fuch as brafs (y), prince's-metal, tombac, bell-metal, white copper, &c. See Chemistry, n° 1154, &c.

If the mixture is made of four to fix parts of copper, with one part of zinc, it is called *Prince's-metal.* If more of the copper is taken, the mixture will be of a deeper yellow, and then goes by the name of *tombac.*

(y) Brafs is frequently made by cementing plates of copper with calamine, where the copper imbibes one-fourth or one-fifth its weight of the zinc which rifes from the calamine. The procefs confifts in mixing three parts of calamine and two of copper with charcoal duft in a crucible, which is expofed to a red heat for fome hours, and then brought to fufion. The vapours of the calamine penetrate the heated plates of copper, and add thereby to its fufiblity, It is of great confequence for the fuccefs of this procefs to have the copper cut into fmall pieces, and intimately blended with the calamine. See Chemistry, n° 1154.

In moft foreign founderies the copper is broken fmall by mechanical means with a great deal of labour; but at

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Bell-metal is a mixture of copper and tin, forming a compound extremely hard and sonorous, and is less subject to alterations by exposure to the air than any other cheap metal. On this account it is advantageously employed in the fabrication of various utensils and articles, as cannons, bells, statues, &c. in the composition of which, however, other metals are mixed in various proportions, according to the fancy and experience of the artist.

White-copper is prepared with arsenic and nitre, as mentioned under CHEMISTRY, n° 1157.

But the principal kind of white-copper is that with which speculums of reflecting telescopes are made. See the article SPECULUM.

VII. Iron; *Ferrum, Mars.* This metal is,

a. Of a blackish blue shining colour.

b. It becomes ductile by repeated heating between coals and hammering.

c. It is attracted by the loadstone, which is an iron ore; and the metal itself may also be rendered magnetical.

d. Its specific gravity to water is as 7,645, or 8000 : 1000.

e. It calcines easily to a black scaly calx, which, when pounded, is of a deep red colour.

f. When this calx is melted in great quantity with glass compositions, it gives a blackish brown colour to the glass; but in a small quantity a greenish colour, which at last vanishes if forced by a strong degree of heat.

g. It is dissolved by all salts, by water, and likewise by their vapours. The calx of iron is dissolved by the spirit of sea-salt and by aqua-regia.

h. The calx of the dissolved metal becomes yellow, or yellowish brown: and in a certain degree of heat it turns red.

i. The same calx, when precipitated from acids by means of the fixed alkali, is of a greenish colour; but it becomes blue when precipitated by means of an alkali united with phlogiston; in which last circumstance the phlogiston unites with the iron: these two precipitates lose their colour in the fire, and turn brown.

k. The vitriol of iron is brown.

Iron is found,

[1.] Native. See the detached article IRON.

[2.] In form of calx.

A. Pure.

A. Loose and friable. Martial ochre; *Minera ochracea.*

1. Powdery; *Ochra ferri.* This is commonly yellow or red, and is iron which has been dissolved by the vitriolic acid.

2. Concreted. Bog-ore.

a. In form of round porous balls.

b. More solid bars.

c. In small flat pieces, like cakes or pieces of money.

d. In small grains.

e. In

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at Bristol the workmen employ an easier method. A pit is dug in the ground of the manufacture about four feet deep, the sides of which are lined with wood. The bottom is made of copper or brass, and is moveable by means of a chain. The top is made also of brass with a space near the centre, perforated with small holes, which are luted with clay; through them the melted copper is poured, which runs in a number of streams into the water, and this is perpetually renewed by a fresh stream that passes through the pit. As the copper falls down it forms itself into grains, which collect at the bottom. But great precaution is required to hinder the dangerous explosions which melted copper produces when thrown into cold water; which end is obtained by pouring small quantities of the metal at once. The granulated copper is completely mixed with powdered calamine, and fused afterwards. The process lasts eight or ten hours, and even some days, according to the quality of the calamine.

It is a wonderful thing, says Cramer, that zinc itself, being simply melted with copper, robs it of all its malleability; but if it be applied in form of vapour from the calamine, the sublimates, or the flowers, it does not cause the metal to become brittle.

The method mentioned by Cramer to make brass from copper, by the volatile emanations of zinc, seems to be preferable to any other process, as the metal is then preserved from the heterogeneous parts contained in the zinc itself, or in its ore. It consists in mixing the calamine and charcoal with moistened clay, and ramming the mixture to the bottom of the melting pot, on which the copper, mixed also with charcoal, is to be placed above the rammed matter. When the proper degree of heat is applied, the metallic vapour of the zinc contained in the calamine will transpire through the clay, and attach itself to the copper, leaving the iron and the lead which were in the calamine retained in the clay, without mixing with the upper metal. Dr Watson says, that a very good metallurgist of Bristol, named John Champion, has obtained a patent for making brass by combining zinc in the vapourous form with heated copper plates; and that the brass from this manufacture is reported to be of the finest kind: but he knows not whether the method there employed is the same with that mentioned by Cramer.

Brass is sometimes made in another way, by mixing the two metals directly; but the heat requisite to melt the copper makes the zinc burn and flame out, by which the copper is defrauded of the due proportion of zinc. If the copper be melted separately, and the melted zinc poured into it, a considerable and dangerous explosion ensues; but if the zinc is only heated and plunged into the copper, it is quickly imbibed and retained. The union, however, of these two metals succeeds better if the flux composed of inflammable substances be first fused in the crucible, and the copper and zinc be poured into it. As soon as they appear thoroughly melted, they are to be well stirred, and expeditiously poured out, or else the zinc will be inflamed, and leave the red copper behind.

e. In lumps of an indeterminate figure.

All these are of a blackish brown, or a light brown colour.

B. Indurated. The blood-stone; *Hæmatites.*

(1.) Of an iron colour; *Hæmatites cœruleſcens.* This is of a bluish grey colour; it is not attracted by the loadstone, yields a red powder when rubbed, and is hard.

a. Solid, and of a dim appearance when broken.

b. Cubical, and of a shining appearance when broken.

c. Fibrous, is the most common *torrsten* of Sweden.

d. Scaly: the *eisenram* of the Germans.

1. Black.
2. Bluish grey. When this is found along with marcasite, it is not only attracted by the loadstone, but is of itself really a loadstone.

e. Crystallised.

1. In octoedrical crystals.
2. In polyedrical crystals.
3. In a cellular form.

These varieties are the most common in Sweden, and are very seldom blended with marcasite or any other heterogeneous substance except their diffeeent beds. It is remarkable, that when these ores are found along with marcasite, those particles which have lain nearest to the marcasite are attracted by the loadstone, although they yield a red or reddish brown powder, like those which are not attracted by the loadstone: it is likewise worth observation, that they generally contain a little sulphur, if they are imbedded in a limestone rock.

(2.) Blackish brown bloodstone; *Hæmatites nigreſcens.* Kidney ore. This yields a red or brown powder when it is rubbed; it is very hard, and is attracted by the loadstone.

a. Solid, with a glassy texture.

b. Radiated.

c. Crystallised.

1. In form of cones, from Siberia.
2. In form of concentric balls, with a facetted surface. These are very common in Germany, but very scarce in Sweden.

(3.) Red bloodstone; *Hæmatites Ruber.* Red kidney ore.

a. Solid, and dim in its texture.

b. Scaly. The *eisenran* of the Germans. This is commonly found along with the iron-coloured iron glimmer, and smears the hands.

c. Crystallised, in concentric balls, with a flat or facetted surface.

(4.) Yellow bloodstone; *Hæmatites flavus.*

a. Solid.

b. Fibrous.

The varieties of the colours in the bloodstone are the same with those produced in the calces of iron made by dry or liquid menstrua and afterwards exposed to different degrees of heat.

B. Mixed with heterogeneous substances.

A. With a calcareous earth. White spathose iron ore. The *stahlstein* of the Germans.

B. With a siliceous earth. The martial jasper of Sinople.

C. With a garnet earth. Garnet and cockle or shirl.

D. With an argillaceous earth. The bole.

E. With a micaceous earth. Mica.

F. With manganese.

G. With an alkali and phlogiston. Blue martial earth. Native Prussian-like blue.

1. Loose or powdery.

H. With an unknown earth, which hardens in water. Tarras; *Cementum.*

1. Loose or granulated; *Terra Puzzolana.* This is of a reddish brown colour, is rich in iron, and is pretty fusible.
2. Indurated; *Cementum induratum.* This is of a whitish yellow colour, contains likewise a great deal of iron, and has the same quality with the former to harden soon in water when mixed with mortar. This quality cannot be owing to the iron alone, but rather to some particular modification of it occasioned by some accidental causes, because these varieties rarely happen at any other places except where volcanoes have been, or are yet, in the neighbourhood.

[3.] Dissolved or mineralised.

A. With sulphur alone.

A. Perfectly saturated; *Ferrum sulphure saturatum.* Marcasite.

B. With very little sulphur. Black iron ore. Iron stone.

This is either attracted by the loadstone, or is a loadstone itself attracting iron; it resembles iron, and yields a black powder when rubbed.

1.) Magnetic iron ore. The loadstone, *Magnes.*

a. Steel-grained, of a dim texture, from Hogberget in the parish of Gagnœf in Dalarne: it is found at that place almost to the day, and is of as great strength as any natural loadstones were ever commonly found.

b. Fine grained, from Saxony.

c. Coarse-grained, from Spetalsgrufvan at Norberg, and Kierrgrufvan, both in the province of Westmanland. This loses very soon its magnetical virtue.

d. With coarse scales, found at Sandswœr in Norway. This yields a red powder when rubbed.

2.) Refractory iron ore. This in its crude state is attracted by the loadstone.

a. Giving a black powder when rubbed; *Tritura atra.* Of this kind are,

1. Steel-grained.
2. Fine grained.

Imperfect METALS. *Iron.*

3. Coarse grained.

This kind is found in great quantities in all the Swedish iron mines, and of this most part of the fusible ores consist, because it is commonly found in such kinds of rocks as are very fusible: and it is as seldom met with in quartz as the hæmatites is met with in limestone.

b. Rubbing into a red powder. These are real hæmatites, that are so far modified by sulphur or lime as to be attracted by the loadstone.

1. Steel-grained.
2. Fine-grained. Emery. This is imported from the Levant: it is mixed with mica, is strongly attracted by the loadstone, and smells of sulphur when put to the fire.
3. Of large shining cubes.
4. Coarse, scaly. The *eisenglimmer* or *eisenran*.

[4.] Mixed with various fossile substances.

1. With sulphur and clay; Pyrites.
2. With arsenic; called *mispickel* by the Germans, and *plate mundic* in Cornwall.
3. With sulphurated arsenic. Arsenical pyrites.
4. With vitriolic acid. Martial vitriol.
5. With phlogiston. Martial coal ore.
6. With other sulphurated and arsenicated metals. See these in their respective arrangements.

Uses and Properties of Iron. Iron is the most common metal in nature, and at the same time the most useful in common life; notwithstanding which, its qualities are perhaps very little known.

Iron has a particular and very sensible smell when strongly rubbed or heated; and a styptic taste, which it communicates to the water in which it is extinguished after ignition. Its tenacity, ductility, and malleability, are very great. It exceeds every other metal in elasticity and hardness, when properly tempered. An iron wire of one-tenth of an inch thick is able to support 450 pounds weight without breaking, as Wallerius asserts.

Iron drawn into wire as slender as the finest hairs. It is more easily malleable when ignited than when cold; whereas other metals, though ductile when cold, become quite brittle by heat.

It grows red-hot sooner than other metals: nevertheless it melts the most difficultly of all, platina and manganese excepted. It does not tinge the flame of burning matters into bluish or greenish colours, like other imperfect metals, but brightens and whitens it; hence the filings of iron are used in compositions of fire-works, to produce what is called *white-fire.*

Iron, or rather steel, expands the least of all hard metals by the action of heat; but brass expands the most: and on this account these two metals are employed in the construction of compound pendulums for the best sort of regulating clocks for astronomical purposes.

Iron, in the act of fusion, instead of continuing to expand, like the other metals, shrinks, as Dr Lewis observes; and thus becomes so much more dense as to throw up such part as is unmelted to the surface; whilst pieces of gold, silver, copper, lead, and tin, put in the respective metals in fusion, sink quickly to the bottom. But in its return to a consistent state, instead of shrinking, like other metals, it expands; sensibly rising in the vessel, and assuming a convex surface, whilst the others subside, and appear concave. This property of iron was first taken notice of by Reamur, and excellently fits it for receiving impressions from the moulds into which it is cast, being forced into their minutest cavities. Even when poured thick into the mould, it takes, nevertheless, a perfect impression; and it is observed, that cast iron is somewhat larger than the dimensions of the mould, whilst cast figures of other metals are generally smaller.

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The vitriolic acid dissolves iron readily, and forms green vitriol.

This acid requires to be diluted with 304 times its quantity of water, to enable it effectually to dissolve iron; and, during the dissolution, a strong aerial fluid arises, called *inflammable air*, which, on being mixed with atmospheric air, takes fire at the approach of the flame of a candle. A glass phial, of about two ounces measure, with one third of inflammable air, and the rest of common air, produces a very loud report if opened in the same circumstance; and if it be filled with two-thirds of inflammable air, mixed with one of dephlogisticated air, the report will be as loud as the explosion of a pistol with gunpowder.

Dilute nitrous acid dissolves iron; but this saline combination is incapable of crystallising. Strong nitrous acid corrodes and dephlogisticates a considerable quantity of iron, which falls to the bottom.

Marine acid likewise dissolves iron, and this solution is also incrystallisable.

The Prussian acid precipitates iron from its solutions in the form of Prussian blue.

This metal is likewise sensibly acted upon by alkaline and neutral liquors, and corroded even by those which have no perceptible saline impregnation; the oils themselves, with which iron utensils are usually rubbed to prevent their rusting, often promote this effect in some measure, unless the oils had been previously boiled with litharge or calces of lead.

Galls, and other astringent vegetables, precipitate iron from its solutions, of a deep blue or purple colour, of so intense a shade as to appear black. It is owing to this property of iron that the common writing ink is made. The infusion of galls, and also the Prussian alkali, are tests of the presence of iron by the colours they produce on any fluid. Acids, however, dissolve the coloured precipitates by the former; and hence it arises that the marine acid is succesfully applied to take off ink spots and iron stains from white linens. Alkalis, however, convert these iron precipitates into a brown ochre.

Iron has a strong affinity with sulphur. If a bar of iron be strongly ignited, and a roll of brimstone be applied to the heated end, it will combine

Semi-metals. *Bismuth.*

bine with the iron, and form a fusible mass, which will drop down. A vessel of water ought to be placed beneath for the purpose of receiving and extinguishing it, as the fumes would otherwise be very inconvenient to the operator.

A mixture of iron-filings and sulphur in powder, moistened with water, and pressed so as to form a paste, will in a few hours swell, become hot, fume, and even burst into a flame, if the quantity is large. The residuum furnishes martial vitriol. This process is similar to the decomposition of martial pyrites; from which some philosophers account for hot spring-waters and subterraneous fires. The mixture of water in this paste seems to be necessary to enable the vitriolic acid of the sulphur to act on the iron.

For other chemical properties of this metal, see Chemistry-*Index*; for its electrical and magnetic properties, see Electricity and Magnetism. For a more particular account of its nature and uses, and the methods of making and manufacturing it, see the articles Iron and Steel; also Metallurgy, Part II. sect. vii. and Part III. sect. v.

Order III. Semimetals.

I. Bismuth; tin-glass. *Vismutum, Bismutum, Marcasita officinalis.* It is,

a. Of a whitish yellow colour.

b. Of a laminated texture, soft under the hammer, and nevertheless very brittle.

c. It is very fusible; calcines and scorifies like lead, if not rather easier; and therefore it works on the cuppel. It is pretty volatile in the fire.

d. Its glass or slag becomes yellowish brown, and has the quality of retaining some part of the gold, if that metal has been melted, calcined, and vitrified with it.

e. It may be mixed with the other metals, except cobalt and zinc, making them white and brittle.

f. It dissolves in aquafortis, without imparting to it any colour; but to the aqua-regia it gives a red colour, and may be precipitated out of both these solutions with pure water into a white powder, which is called *Spanish white*. It is also precipitated by the acid of sea-salt; which last unites with it, and makes the *vismutum corneum*.

g. It amalgamates easily with quicksilver. Other metals are so far attenuated by the bismuth, when mixed with it, as to be strained or forced along with the quicksilver through skins or leather.

Bismuth is found in the earth.

A. Native. This resembles a regulus of bismuth, but consists of smaller scales or plates.

1. Superficial, or in crusts.
2. Solid, and composed of small cubes.

B. In form of calx.

1. Powdery or friable; *Ochra vismuti.* This is of a whitish yellow colour; it is found in form of an efflorescence.

It has been customary to give the name of *flowers of bismuth* to the pale red calx of cobalt, but it is wrong; because neither the calx of bismuth, nor its solutions, become red, this being a quality belonging to the cobalt.

C. Mineralised bismuth. This is, with respect to colour and appearance, like the coarse tessellated potter's lead ore; but it consists of very thin square plates or flakes, from which it receives a radiated appearance when broken crosswise.

1. With sulphur.
   a. With large plates or flakes.
   b. With fine or small scales.
2. With sulphurated iron.
   a. Of coarse wedge-like scales.

This mineralised bismuth ore yields a fine radiated regulus; for which reason it has been ranked among the antimonial ores by those who have not taken proper care to melt a pure regulus ore destitute of sulphur from it; while others, who make no difference between regulus and pure metals, have still more positively asserted it to be only an antimonial ore.

3. With sulphur and arsenic.
   a. Of a whitish yellow or ash colour. It has a shining appearance; and is composed of small scales or plates, intermixed very small yellow flakes: It is of a hard and solid texture: Sometimes strikes fire with hard steel: Has a disagreeable smell when rubbed: Does not effervesce with aqua-fortis; but is partially dissolved by the same acid (z).
   b. Grey, of a striated form; found at Helsingland in Sweden, and at Annaberg in Saxony.
   c. With variegated colours of red, blue, and yellow grey; found at Schneeberg in Saxony.
   d. With green fibres like an amianthus; at Misnia in Germany, and at Gillebeck in Norway.
   e. With yellow red shining particles, called *mines de bismuth Tigrées* in French, at Georgenstadt in Germany, and at Annaberg in Saxony.
   f. The *minera bismuthi arenacea*, mentioned by Wallerius and Bomare, belongs also to the same kind of the arsenicated ores.
4. By vitriolic acid. This ore is called *wismuth bluth* by the Germans. It is said to be of a yellowish, reddish, or variegated colour; and to be found mixed with the calx of bismuth, incrusting other ores. *Kirwan*, p. 334.

Uses, &c. of Bismuth. See the article Bismuth. Also Chemistry-*Index*; and Metallurgy, Part II. sect. x. and Part III. sect. viii.

II.

(z) This solution, being diluted with water, becomes a kind of sympathetic ink; as the words written with it on white paper, and dried, are not distinguished by the eye; but on being heated before the fire, they assume a yellowish colour.

SEMI-METALS. *Zinc.*

II. Zinc; ſpeltre. *Zincum.*

a. Its colour comes neareſt to that of lead, but it does not ſo eaſily tarniſh.

b. It ſhows a texture when it is broken, as if it were compounded of flat pyramids (A).

c. Its ſpecific gravity to water is as 6,900 or 7000 to 1000.

d. It melts in the fire before it has acquired a glowing heat; but when it has gained that degree of heat, it burns with a flame of a changeable colour, between blue and yellow. If in an open fire, the calx riſes in form of ſoft white flowers; but if in a covered veſſel, with the addition of ſome inflammable, it is diſtilled in a metallic form: in which operation, however, part of it is ſometimes found vitrified.

e. It unites with all the metals (B) except biſmuth and nickel, and makes them volatile. It is, however, not eaſy to unite it with iron without the addition of ſulphur. It has the ſtrongeſt attraction to gold and copper, and this laſt metal acquires a yellow colour by it; which has occaſioned many experiments to be made to produce new metallic compoſitions.

f. It is diſſolved by all the acids: of theſe the vitriolic acid has the ſtrongeſt attraction to it; yet it does not diſſolve it, if it is not previouſly diluted with much water.

g. Quickſilver amalgamates eaſier with zinc than with copper; by which means it is ſeparated from compoſitions made with copper.

h. It ſeems to become electrical by friction.

Zinc is found,

A. Native.

Zinc has been met with native, though rarely, in the form of thin and flexible filaments, of a grey colour, which were eaſily inflamed when applied to a fire. And Bomare affirms that he has ſeen many ſmall pieces of native zinc among the calamine-mines in the duchy of Limbourg and in the zinc-mines at Goſlar, where this ſemimetal was always ſurrounded by a kind of ferrugineous yellow earth, or ochraceous ſubſtances. See the detached article ZINC.

B. In form of calx.

(1.) Pure.

a. Indurated.

1. Solid

2. Cryſtalliſed.

This is of a whitiſh-grey colour, and its external appearance is like that of a lead ſpar; it cannot be deſcribed, but is eaſily known by an experienced eye. —It looks very like an artificial glaſs of zinc; and is found among other calamines at Namur and in England.

(2.) Mixed.

A. With a martial ochre.

1. Half indurated. Calamine; *Lapis calaminaris.*

a. Whitiſh yellow.

b. Reddiſh brown. This ſeems to be a mouldered or weathered blende.

B. With a martial clay or bole.

C. With a lead ochre and iron.

D. With quartz: Zeolite of Friburgh.

The real contents of this ſubſtance were firſt diſcovered by M. Pelletier. It was long taken for a true zeolite, being of a pearl colour, cryſtalliſed, and ſemitranſparent. It conſiſts of laminæ, diverging from different centres, and becoming gelatinous with acids. Its contents are 48 to 52 per cent. of quartz, 36 of calx of zinc, and 8 or 12 of water. (*Kirwan*, p. 318.)

C. Mineraliſed.

(1.) With ſulphurated iron. Blende, mock-lead, black-jack, mock-ore; *pſeudogalena* and *blende* of the Germans

A. Mineraliſed zinc in a metallic form. Zinc ore. This is of a metallic bluiſh-grey colour, neither perfectly clear as a potter's ore, nor ſo dark as the Swediſh iron ores.

1. Of a fine cubical or ſcaly texture.

2. Steel-grained.

B. In form of calx. Blende. Mock-lead; *Sterile nigrum. Pſeudo-galena* (C). This is found,

1. With courſe ſcales.

a. Yellow; ſemi-tranſparent.

b. Greeniſh.

c. Greeniſh-

(A) It cannot be reduced into powder under the hammer like other ſemimetals. When it is wanted very much divided, it muſt be granulated, by pouring it while fuſed into cold water; or filed, which is very tedious, as it ſtuffs and fills the teeth of the file. But if heated the moſt poſſible without fuſing it, Macquer aſſerts, that it becomes ſo brittle as to be pulveriſed in a mortar.

(B) It brightens the colour of iron almoſt into a ſilver hue; changes that of copper to a yellow or gold colour, but greatly debaſes the colour of gold and deſtroys its malleability. It improves the colour and luſtre of lead and tin, rendering them firmer, and conſequently fitter for ſundry mechanic uſes. Lead will bear an equal weight of zinc, without loſing too much of its malleability.—The proceſs for giving the yellow colour to copper, by the mixture of zinc, and of its ore called *calamine*, has been deſcribed above under the *Uſes of Copper*.

(C) The varieties of pſeudo-galena, or black-jack, are in general of a lamellar or ſcaly texture, and frequently of a quadrangular form, reſembling galena. They all loſe much of their weight when heated, and burn with a blue flame; but their ſpecific gravity is conſiderably inferior to that of true galena. Almoſt all contain a mixture of lead-ore. Moſt of them exhale a ſulphureous ſmell when ſcraped; or at leaſt when vitriolic or marine acid is dropped on them.

c. Greeniſh-black; *pechblende*, or *pitch blende* of the Germans.
d. Blackiſh-brown.
2. With fine ſcales,
a. White.
b. Whitiſh-yellow.
c. Reddiſh-brown.

3. Fine and ſparkling; at Goſlar called *braun blyertz*. Its texture is generally ſcaly; ſometimes cryſtalliſed and ſemitranſparent. It gives fire with ſteel; but does not decrepitate, nor ſmoke when heated: yet it loſes about 13 *per cent.* of its weight by torrefaction.
a. Dark-brown.
b. Red, which becomes phoſphoreſcent when rubbed; found at Scharfenberg in Miſnia. (*Brunich*).
c. Greeniſh, yellowiſh-green, or red. It has different degrees of tranſparency, and is ſometimes quite opaque. When ſcraped with a knife in the dark, it emits light, even in water; and after undergoing a white heat, if it is diſtilled *per ſe*, a ſiliceous ſublimate riſes, which ſhows it contains the ſparry acid, probably united to the metal, ſince it ſublimes.

4. Of a metallic appearance; *glanz blende*.

This is of a bluiſh-grey, of a ſcaly or ſteel grained texture, and its form generally cubical or rhomboidal. It loſes nearly one ſixth of its weight by calcination; and after calcination it is more ſoluble in the mineral acids.

100 parts of this ore afforded to Bergman about 52 of zinc, 8 of iron, 4 of copper, 26 of ſulphur, 6 of ſilex, and 4 of water.

5. Cryſtalline.
a. Dark-red, very ſcarce; found in a mine near Freyberg. Something like it is found at the Morgenſtern and Himmelsfuſte.
b. Brown. In Hungary and Tranſilvania.
c. Black. Hungary.

Theſe varieties may eaſily be miſtaken for rock cryſtals; but by experience they may be diſtinguiſhed on account of their lamellated texture and greater ſoftneſs. Their tranſparency ariſes from a very ſmall portion of iron in them.

(2.) Zinc mineraliſed by the vitriolic acid.

This ore has been already deſcribed among the middle *Salts*, at *Vitriol of zinc*.

Uſes, &c. *of zinc*. See the detached article Zinc: Alſo Chemistry-*Index*; and Metallurgy, Part II. ſect. xii. and Part III. under ſect. iii.

III. Antimony; *Antimonium Stibium*. This ſemimetal is,
a. Of a white colour almoſt like ſilver.
b. Brittle; and, in regard to its texture, it conſiſts of ſhining planes of greater length than breadth.
c. In the fire it is volatile, and volatiliſes part of the other metals along with it, except gold and platina. It may, however, in a moderate fire, be calcined into a light-grey calx, which is pretty refractory in the fire; but melts at laſt to a glaſs of a reddiſh-brown colour.
d. It diſſolves in ſpirit of ſea-ſalt and aqua regia, but is only corroded by the ſpirit of nitre into a white calx; it is precipitated out of the aqua regia by water.
e. It has an emetic quality when its calx, glaſs, or metal, is diſſolved in an acid, except when in the ſpirit of nitre, which has not this effect.
f. It amalgamates with quickſilver, if the regulus, when fuſed, is put to it; but the quickſilver ought for this purpoſe to be covered with warm water: it amalgamates with it likewiſe, if the regulus of antimony be previouſly melted with an addition of lime.

Antimony is found in the earth.

A. Native. *Regulus antimonii nativus*.

This is of a ſilver colour, and its texture is compoſed of pretty large ſhining planes.

This kind was found in Carls Ort, in the mine of Salberg, about the end of the laſt century; and ſpecimens thereof have been preſerved in collections under the name of an arſenical pyrites, until the mine-maſter Mr Von Swab diſcovered its real nature, in a treatiſe he communicated to the Royal Academy of Sciences at Stockholm in the year 1748. Among other remarkable obſervations in this treatiſe, it is ſaid, firſt, That this native antimony eaſily amalgamated with quickſilver; doubtleſs, becauſe it was imbedded in a limeſtone; ſince, according to Mr Pott's experiments, an artificial regulus of antimony may, by means of lime, be diſpoſed to an amalgamation: Secondly, That when brought in form of a calx, it ſhot into cryſtals during the cooling.

B. Mineraliſed antimony.

(1.) With ſulphur.

This is commonly of a radiated texture, compoſed of long wedge-like flakes or plates; it is nearly of a lead-colour, and rough to the touch.
a. Of coarſe fibres.
b. Of ſmall fibres.
c. Steel-grained, from Saxony and Hungary.
d. Cryſtalliſed, from Hungary.
1. Of a priſmatical, or of a pointed pyramidal figure, in which laſt circumſtance the points are concentrical.

Cronſtedt mentions a ſpecimen of this, in which the cryſtals were covered with very minute cryſtals or quartz, except at the extremities, where there was always a little hole: this ſpecimen was given for a *flos ferri* ſpar.

(2.) With ſulphur and arſenic. Red antimony ore; *Antimonium ſolare*.

This is of a red colour, and has the ſame texture with the preceding, though its fibres are not ſo courſe.

a. With ſmall fibres.

b. With abrupt broken fibres, from Braunſdorff in Saxony, and from Hungary.

All antimonial ores are ſomewhat arſenical, but this is more ſo than the preceding kinds.

(3.) With ſulphurated ſilver. Plumoſe ſilver-ore, or *federertz* of the Germans.

(4.) With ſulphurated ſilver, copper, and arſenic; the *dal fahl-ertz* of the Germans.

(5.) With ſulphurated lead; radiated lead-ore.

(6.) By the aerial acid.

This ore was lately diſcovered by Mongez, among thoſe of native antimony from the mine of Chalanges in Dauphiny. It conſiſts of a group of white cryſtalliſed filaments of a needle-form appearance, diverging from a common centre, like zeolite. They are inſoluble in nitrous acid; and, on being urged by the flame of a blow-pipe, upon a piece of charcoal, they are diſſipated into white fumes, or antimonial flowers, without any ſmell of arſenic; from whence it follows, that theſe needle-formed cryſtals are a pure calx of antimony, formed by its combination with, or mineraliſed by, the aerial acid. See *Kirwan*, p. 325, and *Journal de Phyſique* for July 1787, p. 67.

Uſes, &c. By the name of *antimony* is commonly underſtood the crude antimony (which is compounded of the metallic part and ſulphur) as it melted out of the ore; and by the name of *regulus*, the pure ſemimetal.

1. Though the regulus of antimony is a metallic ſubſtance, of a conſiderably bright white colour, and has the ſplendor, opacity, and gravity of a metal, yet it is quite unmalleable, and falls into powder inſtead of yielding or expanding under the hammer: on which account it is claſſed among the ſemimetals.

2. Regulus of antimony is uſed in various metallic mixtures, as for printing types, metallic ſpeculums, &c. and it enters into the beſt ſort of pewter ware.

3. It mixes with, and diſſolves various metals; in particular it affects iron the moſt powerfully; and, what is very remarkable, when mixed together, the iron is prevented from being attracted by the loadſtone.

4. It affects copper next, then tin, lead, and ſilver; promoting their fuſion, and rendering them all brittle and unmalleable: but it will neither unite with gold nor mercury; though it may be made to combine with this laſt by the interpoſition of ſulphur. In this caſe it reſembles the common Æthiops, and is thence called *antimonial Æthiops*.

5. Regulus of antimony readily unites with ſulphur, and forms a compound of a very faint metallic ſplendor: it aſſumes the form of long needles adhering together laterally: it uſually formed naturally alſo in this ſhape. This is called *crude antimony*.

6. But though antimony has a conſiderable affinity to ſulphur; yet all the metals, except gold and mercury, have a greater affinity to that compound. If therefore iron, copper, lead, ſilver, or tin, be melted with antimony, the ſulphur will unite with the metal, and be ſeparated from the regulus, which, however, takes up ſome part of the metal, for which reaſon it is called *martial regulus*, *regulus veneris*, &c.

7. When gold is mixed, or debaſed by the mixture of other metals, it may be fuſed with antimony; for the ſulphur combines with the baſe metals, which, being the lighter, riſe up into ſcoria, while the regulus remains united at the bottom with the gold; which being urged by a ſtronger degree of heat, is freed from the ſemimetal, which is very volatile. This method of refining gold is the eaſieſt of all.

8. But the moſt numerous purpoſes to which this metal has been applied are thoſe of the chemical and pharmaceutical preparations. Lemery, in his Treatiſe on Antimony, deſcribes no leſs than 200 proceſſes and formulæ; among which there are many good and many uſeleſs ones. The following deſerve to be mentioned on account of their utility.

9. Antimony melts as ſoon as it is moderately red hot, but cannot ſuſtain a violent degree of fire, as it is thereby diſſipated into ſmoke and white vapours, which adhere to ſuch cold bodies as they meet with, and are collected into a kind of farina or powder, called *flowers of antimony*.

10. If it be only moderately heated, in very ſmall pieces, ſo as not to melt, it becomes calcined into a greyiſh powder deſtitute of all ſplendor, called *calx of antimony*. This calx is capable of enduring the moſt violent fire; but at laſt it will run into a glaſs of a reddiſh-yellow colour, ſimilar to that of the hyacinth. The infuſion made of this coloured antimonial glaſs, in acidulous wine (ſuch as that of Bourdeaux) for the ſpace of 5 or 6 hours, is a very violent emetic.

11. If equal parts of nitre and regulus of antimony be deflagrated over the fire, the grey calx which remains is called *liver of antimony*.

12. If regulus of antimony be melted with two parts of fixed alkali, a maſs of a reddiſh-yellow colour is produced, which being diſſolved in water, and any acid being afterwards added, a precipitate is formed of the ſame colour, called *golden ſulphur of antimony*.

13. Fixed nitre, viz. the alkaline ſalt that remains after the deflagration of nitre, being boiled with ſmall pieces of regulus of antimony, the ſolution becomes reddiſh; and, on cooling, depoſits the antimony in the form of a red powder, called *mineral kermes*.

14. Equal parts of the glaſs, and of the liver of antimony, well pulveriſed and mixed with an equal quantity of pulveriſed cream of tartar, being put into as much water as will diſſolve the cream of tartar, and boiled for 12 hours, adding now and then ſome hot water to replace what is evaporated, the whole is to be filtered while hot; then being evaporated to dryneſs, the ſaline matter that remains is the emetic tartar.

15. The regulus of antimony being pulveriſed, and diſtilled

diſtilled with corroſive ſublimate of mercury, a thick white matter is produced, which is extremely corroſive, and is called *butter of antimony*. This thick ſubſtance may be rendered limpid and fluid by repeated diſtillations.

16. On mixing the nitrous acid with this butter of antimony, a kind of aqua regia is diſtilled, called *bezoardic ſpirit of nitre*.

17. The white matter that remains from this laſt diſtillation may be rediſtilled with freſh nitrous acid; and the remainder being waſhed with water, is called *bezoar mineral*, which is neither ſo volatile nor ſo cauſtic as the antimonial butter. This butter being mixed with water, a precipitate falls to the bottom, which is very improperly called *mercurius vitæ*, for it is in fact a very violent emetic.

18. But if, inſtead of the regulus, crude antimony be employed, and the ſame operation be performed, the reguline part ſeparates from the ſulphur, unites to the mercury, and produces the ſubſtance which is called *cinnabar of antimony*.

19. Crude antimony being projected in a crucible, in which an equal quantity of nitre is fuſed, detonates; is calcined, and forms a compound called by the French *fondant de Retrou*, or *antimoine diaphoretique non lavé*. This being diſſolved in hot water, falls to the bottom after it is cold; and after decantation is known, when dry, by the name of *diaphoretic antimony*. This preparation excites animal perſpiration, and is a good ſudorific. The ſame preparation may be more expeditiouſly made by one part of antimony with two and a half of nitre, mixed together and deflagrated: the reſidue of which is the mere calx of antimony, void of all emetic power.

20. And if the detonation be performed in a tubulated retort, having a large receiver, containing ſome water adapted to it, both a clyſſus of antimony and the antimonial flowers may be obtained at the ſame time, as Neumann aſſerts.

21. When nitre is deflagrated with antimony over the fire, the alkaline baſis of the nitre unites with the calx of the ſemimetal, which may be ſeparated by an acid, and is called *materia perlata*. See farther the article ANTIMONY; alſo METALLURGY, Part II. ſect. ix.

IV. Arſenic. In its metallic form, is,

a. Nearly of the ſame colour as lead, but brittle, and changes ſooner its ſhining colour in the air, firſt to yellow, and afterwards to black.

b. It appears laminated in its fractures, or where broken.

c. Is very volatile in the fire, burns with a ſmall flame, and gives a very diſagreeable ſmell like garlic.

d. It is, by reaſon of its volatility, very difficult to be reduced, unleſs it is mixed with other metals: However, a regulus may be got from the white arſenic, if it is quickly melted with equal parts of pot aſhes and ſoap; but this regulus contains generally ſome cobalt, moſt of the white arſenic being produced from the cobalt ores during their calcination. The white arſenic, mixed with a phlogiſton, ſublimes likewiſe into octoedral cryſtals of a metallic appearance, whoſe ſpecific gravity is 8,308.

e. The calx of arſenic, which always, on account of its volatility, muſt be got as a ſublimation, is white, and eaſily melts to a glaſs, whoſe ſpecific gravity is 5,000. When ſulphur is blended in this calx, it becomes of a yellow, orange, or red colour; and according to the degrees of colour is called *orpiment* or yellow arſenic; *ſandarach*, *realgar*, or red arſenic; and alſo *rubinus arſenici*.

f. This calx and glaſs are diſſoluble in water, and in all liquids; though not in all with the ſame facility. In this circumſtance arſenic reſembles the ſalts; for which reaſon it alſo might be ranked in that claſs.

g. The regulus of arſenic diſſolves in ſpirit of nitre; but as it is very difficult to have it perfectly free from other metals, it is yet very little examined in various menſtrua.

h. It is poiſonous, eſpecially in form of a pure calx or glaſs: But probably it is leſs dangerous when mixed with ſulphur, ſince it is proved by experience, that the men at mineral works are not ſo much affected by the ſmoke of this mixture as by the ſmoke of lead, and that ſome nations make uſe of the red arſenic in ſmall doſes as a medicine.

i. It unites with all metals, and is likewiſe much uſed by nature itſelf to diſſolve, or, as we term it, to *mineraliſe*, the metals, to which its volatility and diſſolubility in water muſt greatly contribute. It is likewiſe moſt generally mixed with ſulphur.

k. It abſorbs or expels the phlogiſton, which has coloured glaſſes, if mixed with them in the fire.

Arſenic is found,

[1.] Native; called *Scherbencobolt* and *Fliegenſtein* by the Germans.

It is of a lead colour when freſh broken, and may be cut with a knife, like black lead, but ſoon blackens in the air. It burns with a ſmall flame, and goes off in ſmoke.

A. Solid and teſtaceous; *Scherbencobolt*.
B. Scaly.
C. Friable and porous; *Fliegenſtein*.
(1.) With ſhining fiſſures.
This is by ſome called *Spigel cobolt*.

[2.] In form of a calx.
A. Pure, or free from heterogeneous ſubſtances.
1. Looſe or powdery.
2. Indurated, or hardened. This is found in form of white ſemi-tranſparent cryſtals.
B. Mixed.
A. With ſulphur.
1. Hardened.
a. Yellow. Orpiment; *Auripigmentum*.
b. Red. Native realgar, or ſandarach.
B. With the calx of tin, in the tin-grains.
C. With ſulphur and ſilver; in the *rothgulden* or red ſilver ore.
D. With calx of lead, in the lead-ſpar.
E. With calx of cobalt, in the efflorefcence of cobalt.

[3.] Mi-

SEMI-METALS. *Cobalt.*

[3.] Mineralised.

A. With fulphur and iron. Arfenical pyrites or marcafite. Thefe kinds in Cornwall are called *filvery* or *white mundics* and *plate mundics*.

This alone produces red arfenic when calcined. It is of a deeper colour than the following.

B. With iron only. This differs with regard to its particles; being,

1. Steel-grained.
2. Coarfe-grained.
3. Cryftallifed.

a. In an octoedral figure. This is the moft common kind.

b. Prifmatical. The fulphureous marcafite is added to this kind when red arfenic is to be made; but in Sweden it is fcarcer than the fulphureous arfenical pyrites.

C. With cobalt, almoft in all cobalt ores.

D. With filver. }
E. With copper. } See under *Silver*, *Copper*, and *Antimony*, *fupra*.
F. With antimony. }

For the *Ufes of Arfenic*, fee the detached article ARSENIC, and CHEMISTRY-*Index*; alfo METALLURGY, Part II. fect. xiii. and Part III. fect. viii.

V. Cobalt.

This femimetal is,

a. Of a whitifh grey colour, nearly as fine-tempered fteel.

b. Is hard and brittle, and of a fine-grained texture; hence it is of a dufky, or not fhining appearance.

c. Its fpecific gravity to water is 6000 to 1000.

d. It is fixed in the fire, and becomes black by calcination: it then gives to glaffes a blue colour, inclining a little to violet, which colour, of all others, is the moft fixed in fire.

e. The concentrated oil of vitriol, aquafortis, and aqua-regia, diffolve it; and the folutions become red. The cobalt calx is likewife diffolved by the fame menftrua, and alfo by the volatile alkali and the fpirit of fea falt.

f. When united with the calx of arfenic in a flow (not a brifk) calcining heat, it affumes a red colour: the fame colour is naturally produced by way of efflorefcence, and is then called the *bloom* or *flowers of cobalt*. When cobalt and arfenic are melted together in an open fire, they produce a blue flame.

g. It does not amalgamate with quikfilver by any means hitherto known.

h. Nor does it mix with bifmuth, when melted with it, without addition of fome medium to promote their union.

[1.] Native cobalt. Cobalt with arfenic and iron in a metallic form.

Pure native cobalt has not yet been found: that which paffes for fuch, according to Kirwan, is mineralifed by arfenic. Bergman, however, in his Sciagraphia, has entered this prefent ore under the denomination of *native cobalt*: and certain it is, that among all the cobaltic ores, this is the neareft to the native ftate of this femimetal. It always contains a fmall quantity of iron, befides the arfenic, by which it is mineralifed.

SEMI-METALS. *Cobalt.*

This is of a dim colour when broken, and not unlike fteel. It is found,

a. Steel-grained, from Loos in the parifh of Farila in the province of Helfingeland, and Schneeberg in Saxony.

b. Fine-grained, from Loos.

c. Coarfe-grained.

d. Cryftallifed:

1. In a dendritical or arborefcent form;
2. Polyhedral, with fhining furfaces;
3. In radiated nodules.

[2.] Calciform cobalt. Cobalt is moft commonly found in the earth mixed with iron.

A. In form of a calx.

1.) With iron without arfenic.

a. Loofe or friable; cobalt ochre. This is black, and refembles the artificial zaffre.

b. Indurated: *Minera cobalti vitrea*. The fchlacken or flag cobalt. This is likewife of a black colour, but of a glaffy texture, and feems to have loft that fubftance which mineralifed it, by being decayed or weathered.

2.) With arfenical acid; cobalt-blut, Germ. *Ochra cobalti rubra*; bloom, flowers, or efflorefcence of cobalt.

a. Loofe or friable. This is often found of a red colour like other earths, fpread very thin on the cobalt ores; and is, when of a pale colour, erroneoufly called *flowers of bifmuth*.

b. Indurated. This is commonly cryftallifed in form of deep red femitranfparent rays or radiations: It is found at Schneeberg in Saxony.

B. Mineralifed.

1.) With fulphurated iron.

This ore is of a light colour, nearly refembling tin or filver. It is found cryftallifed in a polygonal form.

a. Of a flaggy texture.

b. Coarfe-grained.

This ore is found in Baftnafgrufva at Raddarfhyttan in Weftmanland, and difcovers not the leaft mark of arfenic. The coarfe-grained becomes flimy in the fire, and fticks to the ftirring hook during the calcination in the fame manner as many regules do: It is a kind of regule prepared by nature. Both thefe give a beautiful colour.

2.) With fulphur, arfenic, and iron. This refembles the arfenicated cobalt ore, being only rather of a whiter or lighter colour. It is found,

a. Coarfe-grained.

b. Cryftallifed;

1. In a polygonal figure, with fhining furfaces, or *glanzkobolt*. It is partly of a white or light colour, and partly of a fomewhat reddifh yellow.

3.) With

3.) With sulphurated and arsenicated nickel and iron; see *Kupfer-nickel*, below.

Uses, &c. See the article Cobalt. See also Chemistry-*Index*; and Metallurgy, Part II. sect. xi.

VI. Nickel; *Niccolum*. This is the latest discovered semimetal. It was first described by its discoverer Mr Cronstedt, in the Acts of the Royal Academy of Sciences at Stockholm for the years 1751 and 1754, where it is said to have the following qualities:

1. It is of a white colour, which, however, inclines somewhat to red.
2. Of a solid texture, and shining in its fractures.
3. Its specific gravity to water is as 8,500 to 1000.
4. It is pretty fixed in the fire; but, together with the sulphur and arsenic, with which its ore abounds, it is so far volatile as to rise in form of hairs and branches, if in the calcination it is left without being stirred.
5. It calcines to a green calx.
6. The calx is not very fusible, but, however, tinges glass of a transparent reddish-brown or jacinth colour.
7. It dissolves in aquafortis, aqua-regia, and the spirit of sea-salt; but more difficultly in the vitriolic acid, tinging all these solutions of a deep green colour. Its vitriol is of the same colour; but the colcothar of this vitriol, as well as the precipitates from the solutions, become by calcination of a light green colour.
8. These precipitates are dissolved by the spirit of sal ammoniac, and the solution has a blue colour; but being evaporated, and the sediment reduced, there is no copper, but a nickel regulus is produced.
9. It has a strong attraction to sulphur; so that when its calx is mixed with it, and put on a scorifying test under the muffel, it forms with the sulphur a regule: this regule resembles the yellow steel-grained copper-ores, and is hard and shining in its convex surface.
10. It unites with all the metals, except quicksilver and silver. When the nickel regulus is melted with the latter, it only adheres close to it, both the metals lying near one another on the same plane; but they are easily separated with a hammer. Cobalt has the strongest attraction to nickel, after that to iron, and then to arsenic. The two former cannot be separated from one another but by their scorification; which is easily done, since,
11. This semimetal retains its phlogiston a long time in the fire, and its calx is reduced by the help of a very small portion of inflammable matter: it requires, however, a red heat before it can be brought into fusion, and melts a little sooner, or almost as soon, as copper or gold, consequently sooner than iron.

Nickel is found,

A. Native.

This is mentioned by Mr Rinman to have been lately met with in a mine of cobalt in Hesse. It is very heavy, and of a liver colour, that is, dark red. When pulverised and roasted under a muffle, it forms green excrescences, and smokes; but its smoke has no particular smell: and no sublimate, whether sulphureous or arsenical, can be caught. It is soluble in acids, and the solution is green; but a polished iron plate discovers no copper.

B. In form of a calx. Nickel ochre, aerated nickel.

1. Mixed with the calx of iron. This is green, and is found in form of flowers on kupfernickel.

C. Mineralised.

1. With sulphurated and arsenicated iron and cobalt; *Kupfernickel*. This is of a reddish yellow colour; and is found,
   - *a.* Of a flaggy texture.
   - *b.* Fine-grained; and
   - *c.* Scaly. These two are often from their colour confounded with the liver-coloured marcasite.
2. With the acid of vitriol. This is of a beautiful green colour, and may be extracted out of the nickel ochre, or efflorescence of the Kupfernickel.

For a full account of this semimetal, see the article Nickel, and Chemistry-*Index*.

VII. Manganese. *Manganesium*.

The ores of this kind are in Swedish called *brunsten*; in Latin *syderea*, or *magnesiæ nigræ*, in order to distinguish them from the *magnesia alba officinalis*; and in French *manganese*, &c.

1. Manganese consists of a substance which gives a colour both to glasses and to the solutions of salts, or, which is the same thing, both to dry and to liquid menstrua, viz.
   - *a.* Borax, which has dissolved manganese in the fire, becomes transparent, of a reddish brown or hyacinth colour.
   - *b.* The microcosmic salt becomes transparent with it, of a crimson colour, and moulders in the air.
   - *c.* With the fixed alkali, in compositions of glass, it becomes violet; but if a great quantity of manganese is added, the glass is in thick lumps, and looks black.
   - *d.* When scorified with lead, the glass obtains a reddish brown colour.
   - *e.* The lixivium of deflagrated manganese is of a deep red colour.
2. It deflagrates with nitre, which is a proof that it contains some phlogiston.
3. When reckoned to be light, it weighs as much as an iron ore of the same texture.
4. When melted together with vitreous compositions, it ferments during the solution: but it ferments in a still greater degree when it is melted with the microcosmic salt.
5. It does not excite any effervescence with the nitrous acid: aqua-regia, however, extracts the colour out of the black manganese, and dissolves likewise a great portion of it, which by means of an alkali is precipitated to a white powder.

6. Such

Semi-metals. Molybdena.

6. Such colours as are communicated to glasses by manganese, are easily destroyed by the calx of arsenic or tin: they also vanish of themselves in the fire.

7. It is commonly of a loose texture, so as to colour the fingers like soot, though it is of a metallic appearance when broken.

Manganese is found,

[1.] Native; of the discovery and qualities of which, an account is given under the article Manganese in its alphabetical order. See also Chemistry-*Index*.

[2.] Calciform.

A. Loose and friable.

a. Black; which seems to be weathered or decayed particles of the indurated kind.

B. Indurated.

1.) Pure, in form of balls, whose texture consists of concentric fibres. *Pura sphærica radiis concentratis.*

a. White; very scarce.

2.) Mixed with a small quantity of iron.

a. Black manganese, with a metallic brightness. This is the most common kind, and is employed at the glass-houses and by the potters. It is found,

1. Solid, of a flaggy texture.
2. Steel-grained.
3. Radiated.
4. Crystallised, in form of coherent hemispheres.

VIII. Molybdena.

A. Lamellar and shining, its colour similar to that of the potter's lead-ore.

This substance resembles plumbago or black-lead; and has long been confounded with it, even by Cronstedt. But it possesses very different properties; in particular,

1. Its laminæ are larger, brighter: and, when thin, slightly flexible. They are of an hexagonal figure.
2. It is of a lead colour, and does not strike fire with hard steel.
3. Its specific gravity is = 4,569, according to Kirwan; and 4,7385, according to Brisson.
4. When rubbed on white papper, it leaves traces of a dark brown or bluish colour, as the plumbago or black lead does; but they are rather of an argentine gloss; by which circumstance the molybdena, according to Dr d'Arcet, may be easily distinguished from black-lead, as the traces made by this last are of less brilliant, and of a deeper tinge.
5. In an open fire, it is almost entirely volatile and infusible. Microcosmic salt or borax scarcely affect it; but it is acted upon with much effervescence by mineral alkali, and forms with it a reddish mass, which smells of sulphur.
6. It consists of an acid of peculiar nature (see Chemistry-*Index*.) united to sulphur. A small proportion of iron is commonly found in it, but this seems merely fortuitous: 100 parts of molybdena contain about 45 of this acid and 55 of sulphur.
7. It is decomposed either by detonation with nitre, or by solution in nitrous acid.
8. This acid is soluble in 570 times its weight of water in the temperature of 60; the solution reddens that of litmus, precipitates sulphur from the solution of liver of sulphur, &c. The specific gravity of the dry acid is 3,460.
9. This acid is precipitable from its solution in water by the Prussian alkali, and also by tincture of galls: the precipitate is reddish brown.
10. If this acid be distilled with three times its weight of sulphur, it reproduces molybdena.
11. The solution of this acid in water unites to fixed alkalies, and forms crystallisable salts; as it also does with calcareous earth, magnesia, and argil: these last combinations are difficultly soluble. It acts also on the base metals, and with them assumes a bluish colour.
12. This solution procipitates silver, mercury, or lead, from the nitrous acid, and lead from the marine, but not mercury.
13. It also precipitates barytes from the nitrous and marine acids, but no other earth. Molybdenous baroselenite is soluble in cold water.
14. This acid is itself soluble in the vitriolic acid by the assistance of heat; and the solution is blue when cold, though colourless while hot; it is also soluble in the marine acid, but not in the nitrous.
15. Molybdena tartar and ammoniac precipitate all metals from their solutions by a double affinity. Gold, sublimate corrosive, zinc, and manganese, are precipitated white; iron or tin, from the marine acid, brown; cobalt, red; copper, blue; alum and calcareous earth, white.
16. This acid has been lately reduced by Mr Hielm; but the properties of the regulus thus obtained are not yet published.
17. Mr Pelletier obtained also the regulus or molybdena, by mixing its powder with oil into a paste, and exposing it with powdered charcoal in a crucible to a very violent fire for two hours. See Chemistry-*Index*, n° 14, 97.
18. This semimetal being urged by a strong fire for an hour, produces a kind of silvery flowers, like those of antimony.
19. Molybdena is said to be soluble in melted sulphur; which seems highly probable, as sulphur is one of its component parts.

See farther the article Molybdena, and Chemistry-*Index*.

Semi-metals. Wolfram.

IX. Wolfram. *Wolfranum*, *Spuma Lupi*, Lat. See the detached article Wolfram.

This mineral has the appearance of manganese, blended with a small quantity of iron and tin.

1. With coarse fibres.

a. Of an iron-colour, from Altenberg in Saxony. This gives to the glass compositions, and also to borax and the microcosmic salt, an opaque whitish yellow colour, which at last vanishes.

X. Siderite. } See those words in the order of the
XI. Saturnite. } alphabet.

Appendix. SAXA.

APPENDIX.

Of Saxa and Petrifactions.

THOUGH the *Saxa*, and foſſils commonly called *Petrifactions*, cannot, in ſtrictneſs, be ranked in a mineral ſyſtem, for the reaſons formerly given; yet as theſe bodies, eſpecially the latter, occupy ſo conſiderable a place in moſt mineral collections, and the former muſt neceſſarily be taken notice of by the miners in the obſervations they make in ſubterranean geography, it appeared proper to ſubjoin them in ſuch an order as might anſwer the purpoſe for which they are regarded by miners and mineralogiſts.

Order I. SAXA, *Petræ*.

Theſe may be divided into two kinds.

1. Compound ſaxa, are ſtones whoſe particles, conſiſting of different ſubſtances, are ſo exactly fitted and joined together, that no empty ſpace, or even cement, can be perceived between them; which ſeems to indicate, that ſome, if not all, of theſe ſubſtances have been ſoft at the inſtant of their union.

2. Conglutinated ſtones, are ſtones whoſe particles have been united by ſome cementitious ſubſtance, which, however, is ſeldom perceivable, and which often has not been ſufficient to fill every ſpace between the particles: in this caſe the particles ſeem to have been hard, worn off, and in looſe, ſingle, unfigured pieces, before they were united.

I. Compound ſaxa.

A. Ophites. Scaly limeſtone with kernels or bits of ſerpentine ſtone in it.

1. *Kolmord marble.* It is white and green.
2. *Serpentino antico*, is white, with round pieces of black ſteatites in it. This muſt not be confounded with the *ſerpentino verde antico.*
3. The *Haraldſio marble.* White, with quadrangular pieces of a black ſteatites.
4. The *marmor pozzevera di Genova.* Dark green marble, with white veins. This kind receives its fine poliſh and appearance from the ſerpentine ſtone.

B. Stellſten or *geſtelſtein.* Granitello.

1. Of diſtinct particles. In ſome of theſe the quartzoſe particles predominate, and in others the micaceous: in the laſt caſe it is commonly flaty, and eaſy to ſplit.
2. Of particles which are wrapt up in one another.
   - *a.* Whitiſh grey.
   - *b.* Greeniſh.
   - *c.* Reddiſh.

C. Norrka. Murkſten of the Swedes. *Saxum compoſitum mica, quartzo, et granato.*

1. With diſtinct garnets or ſhirl.
   - *a.* Light grey.
   - *b.* Dark grey.
   - *c.* Dark grey, with priſmatical, radiated, or fibrous cockle or ſhirl.
2. With kernels of garnet-ſtone.
   - *a.* Of pale red garnet ſtone.

The firſt of this kind, whoſe flaty ſtrata makes it commonly eaſy to be ſplit, is employed for mill-ſtones, which may without difficulty be accompliſhed, if ſand is firſt ground with them; becauſe the ſand wearing away the micaceous particles on the ſurfaces, and leaving the garnets predominent, renders the ſtone fitter for grinding the corn.

D. The whetſtone, *Cos. Saxum compoſitum mica, quartzo, et forſan argilla martiali in nonnullis ſpeciebus.*

1. Of coarſe particles.
   - *a.* White.
   - *b.* Light grey.
2. Of fine particles.
   - *a.* Liver-brown colour.
   - *b.* Blackiſh grey.
   - *c.* Light grey.
   - *d.* Black. The table-ſlate, or that kind uſed for large tables and for ſchool ſlates.
3. Of very minute and cloſely combined particles. The Turkey-ſtone *. This is of an olive colour, and ſeems to be the fineſt mixture of the firſt ſpecies of this genus. The beſt of this ſort come from the Levant, and are pretty dear. The whetſtone kinds, when they ſplit eaſily and in thin plates, are very fit to cover houſes with, though moſt of them are without thoſe properties.

* See V. (p. 86. col. 1.)

F. Porphyry; *Porphyrites.* Italorum *porfido. Saxum compoſitum jaſpide et feltſpato, interdum mica et baſalte* (D). See the article PORPHYRY.

- *a.* Its colour is green, with light-green feltſpat, *Serpentino verde antico.* It is ſaid to have been brought from Egypt to Rome, from which latter place the ſpecimens of it now come.
- *b.* Deep red, with white feltſpat.
- *c.* Black, with white and red feltſpat.
- *d.* Reddiſh brown, with light red and white feltſpat.
- *e.* Dark grey, with white grains of feltſpat alſo. The dark red porphyry has been moſt employed for ornaments in building; yet it is not the only one known by the name

(D) Great part of the hill of Bineves in Lochaber is compoſed of a kind of porphyry. It is remarkably fine, beautiful, and of an elegant reddiſh colour; "in which (ſays Mr Williams) the pale roſe, the bluſh, and the yellowiſh white colours, are finely blended and ſhaded through the body of the ſtone; which is of a jelly-like texture, and is undoubtedly one of the fineſt and moſt elegant ſtones in the world. On this hill alſo is found a kind of porphyry of a greeniſh colour, with a tinge of browniſh red. It is ſmooth, compact, and heavy; of a cloſe uniform texture, but has no brightneſs when broken. It has angular ſpecks in it of a white quartzy ſubſtance."

Appendix. SAXA.

name of *porfido*, the Italians applying the same name alſo to the black kind.

G. The *trapp* of the Swedes. *Saxum compoſitum jaſpide martiali molli, ſeu argilla martiali indurata.* See the article TRAPP.

This kind of ſtone ſometimes conſtitutes or forms whole mountains; as, for example, the mountain called *Hunneberg* in the province of Weſtergotland, and at Drammen in Norway; but it is oftener found in form of veins in mountains of another kind, running commonly in a ſerpentine manner, contrary or acroſs to the direction of the rock itſelf. It is not homogeneous, as may be plainly ſeen at thoſe places where it is not preſſed cloſe together; but where it is preſſed cloſe, it ſeems to be perfectly free from heterogeneous ſubſtances.—When this kind is very coarſe, it is interſperſed with feltſpat; but it is not known if the finer ſorts likewiſe contain any of it. Beſides this, there are alſo ſome fibrous particles in it, and ſomething that reſembles a calcareous ſpar; this, however, does not ferment with acids, but melts as eaſy as the ſtone itſelf, which becomes a black ſolid glaſs in the fire. By calcination it becomes red, and yields in aſſays 12 or more *per cent.* of iron. No other ſort of ore is to be found in it, unleſs now and then ſomewhat merely ſuperficial lies in its fiſſures; for this ſtone is commonly, even to a great depth in the rock, cracked in acute angles, or in form of large rhomboidal dice. It is employed at the glaſs-houſes, and added to the compoſition of which bottles are made. In the air it decays a little, leaving a powder of a brown colour; it cracks commonly in the fire, and becomes reddiſh brown if made red-hot. It is found,

1. Of coarſe chaffy particles.
   a. Dark grey.
   b. Black.
2. Coarſe-grained.
   a. Dark grey.
   b. Reddiſh.
   c. Deep brown.
3. Of fine imperceptible particles.
   a. Black. The touchſtone; *Lapis lydius.*
   b. Bluiſh.
   c. Grey.
   d. Reddiſh.

The black variety (3. *a.*) is ſometimes found ſo compact and hard, as to take a poliſh like the black agate: it melts, however, in the fire to a black glaſs; and is, when calcined, attracted by the load-ſtone.

H. Amygdaloides. The carpolithi or fruit-ſtone rocks of the Germans.

It is a martial jaſper, in which elliptical kernels of calcareous ſpar and ſerpentine ſtone are included.

a. Red, with kernels of white limeſtone, and of a green ſteatites. This is of a particular appearance, and when calcined is attracted by the loadſtone; it decays pretty much in the air, and has ſome affinity with the trapp, and alſo with the porphyry. There are ſometimes found pieces of native copper in this ſtone.

I. The *grønſten* of the Swedes.

Its baſis is horneblende, interſperſed with mica. It is of a dark green colour, and in Smoland is employed in the iron furnaces as a flux to the bog-ore.

K. The granite. *Saxam compoſitum feltſpata, mica et quartzo, quibus accidentaliter interdum horneblende ſteatites, granatus et baſaltes immixti ſunt.* Its principal conſtituent parts are felt-ſpat, or rhombic quartz, mica, and quartz. See the article GRANITE.

It is found,

(1.) Looſe or friable. This is uſed at the Swediſh braſs-works to caſt the braſs in, and comes from France.

(2.) Hard and compact.
   a. Red.
      1. Fine-grained;
      2. Coarſe-grained.
   b. Grey, with many and various colours (E).

II. Con-

(E) Mr Wiegleb has analyſed a ſpecies of green granite found in Saxony. The cryſtals are heaped together, and form very compact layers; the colour ſometimes an olive green, ſometimes reſembling a pear, and ſometimes of a reddiſh brown; ſome of them being perfectly tranſparent, and others nearly ſo. According to Mr Warren, they contain 25 per cent. of iron; whence they have been called green ore of iron. An ounce of theſe cryſtals heated red hot in a crucible loſt two grains in weight, and became of the colour of honey. The remainder was put into a retort, and diſtilled with marine acid, with which it evidently efferveſced. The reſiduum was lixiviated with diſtilled water, freſh muriatic acid added, and the diſtillation and lixiviation repeated. The iron precipitated from this lixivium, and reduced partly to its metallic ſtate, weighed two drachms. M. Wiegleb concludes, that the ſpecimen contained two drams 26½ grains of lime. From further experiments he concludes, that 100 parts of the ſubſtance contained 36.5 of ſiliceous earth; lime 30.8; iron 28.7; and water and fixed air 4.0.

Scotland is remarkable for a great number of excellent granites, little or nothing inferior to porphyry. Of theſe the following kinds are mentioned by Mr Williams.

1. The grey granite, or *moor-ſtone* as it is called in Cornwall, is very common in this country. In ſome places it ſhows no marks of ſtrata; and in others it is diſpoſed in thick unwieldy irregular beds, which are commonly broken tranſverſely into huge maſſes or blocks of various ſizes and ſhapes. There is a great variety in this kind of ſtones; ſome of them differing but little in appearance from baſaltes; others are compoſed of almoſt equal parts of black and white grains, about the ſize of ſmall peaſe, whence it is called *peaſy whin* by the

II. Conglutinated faxa.

A. Of larger or broken pieces of ftones of the fame kinds conglutinated together. *Breccia.*

1. Of limeftone cemented by lime.

a. Calcareous breccia; the *marmi brecciati* of the Italians.

When thefe kinds have fine colours, they are polifhed and employed for ornaments in architecture and other œconomical ufes.

b. The *lumachella* of the Italians, or fhell marbles. Thefe are a compound of fhells and corals, which are petrified or changed into lime, and conglutinated with a calcareous fubftance. When they have many colours, they

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the common people. In Galloway and other places it frequently has a longitudinal grain, as if the component parts had been all moved one way by a gentle flow of water. When this kind of granite begins to undergo a fpontaneous decompofition by expofure to the atmofphere, we obferve that it is compofed of pretty large grains of the figures of cubes, rhomboids, &c. fome of them fo large as to deferve the name of fragments; and the largeft of thefe are always of quartz or feldfpath, and talc.

2. Reddifh granite, of a gellied texture, which, Mr Williams fays, is one of the fineft and moft elegant ftones in the world. The mountains of Bineves, he fays, are principally compofed of this ftone; and it is found in great abundance in many other parts of Scotland, but he never faw it exhibit any marks of ftratification.

3. The fine reddifh granites, in which feveral fine fhades of colours are blended together, not fpread out in tints as in the former. Neither this nor the former are ftratified: "On the contrary (fays our author), both exhibit fuch a degree of uniform regularity, that in fome places there is no difference between a ftone and a mountain, excepting only in magnitude; as many mountains of granite are nothing more than one regularly uniform mafs throughout, in which not the leaft mark of a bed is to be feen, nor hardly a crack or fiffure, unlefs it be at the edge of fome precipice or declivity. Thefe two varieties of elegant red granite are met with in the Highlands and Lowlands of Scotland, in Galloway, and many other places. We often find maffes of talc fo large in this fecond variety, that fome of them may be called fragments, not difpofed in any order, but higgledy-piggledy through the body of the ftone.

4. Stratified reddifh granite, refembling the third in colour and quality, but not always quite fo pure or free from admixture of other ftony matter of a different quality. This variety frequently contains larger and fmaller fragments of fine laminated talc. Mr Williams, however, has feen this kind of granite difpofed in pretty regular ftrata in the fhires of Moray and Nairn, and other parts of Scotland.

5. Granite of a white and whitifh colour, generally of a granulated texture, containing a great quantity of mica, or fmall-leaved talc, and the grains of quartz fometimes large and angular. This variety is fubject to fpontaneous decompofition; part frequently diffolves and falls into lakes, in fuch an exceedingly fine and attenuated ftate, that it does not fink in the water. "I have found (fays Mr Williams) this fubftance in many places where water had been accidentally drained off, refembling fine fhell marle, only much lighter. When thoroughly dry, it is the lighteft foffile fubftance I ever handled; and, when blanched with rain, it is as white as fnow. This variety of granite is either not ftratified, or exhibits thick irregular beds. It frequently contains a confiderable quantity of talc, in maffes and fcales too large to be called mica."

Our author is of opinion, that this fine white fubftance produced from the decompofition of the granite, is the true kaolin of the Chinefe, one of the component parts of porcelain ware. "The authors of the Hiftory of China (fays he) informs us, that the fine porcelain ware is compofed of two different foffile fubftances, called by them *petuntfe* and *kaolin*. We are further told, that the petuntfe is a fine white vitrefcible ftone, compact and ponderous, and of confiderable brightnefs in the infide when broken, which they grind to a fine powder; and that the kaolin is not a ftone, but a fine white earthy fubftance, not vitrifiable, at leaft not in the heat of a common potter's furnace: that they mix the kaolin and the flour of the petuntfe together, and form a pafte of this mixture, which they mou'd into all forts of porcelain veffels. Now, from the beft accounts of this matter which I have been able to obtain, after a good deal of fearch and inquiry, it appears to me, that the fediment which I have mentioned above is the true kaolin; and that as the fine white glaffy quartz, which is found in irregular maffes, and in irregular difcontinuous veins or ribs, in fome of the rocks of fchiftus, is the true petuntfe; and if this obfervation is really true, it deferves to be remarked, that Scotland is as well furnifhed with the beft materials for making fine porcelain as moft countries in the world. The fpecies of quartz which I fuppofe to be petuntfe is of a pure fine uniform glaffy texture, femitranfparent, and of a pure fnowy whitenefs. A broken piece of this ftone, and a newly broken piece of fine porcelain, are very like one another. There is a great quantity of petuntfe, or pure white quartz, in many places of Scotland, particularly in the north and Highlands. There is a confiderable quantity of it upon the fhore and wafhed by the tide between Banff and Cullen, generally in pretty large maffes in rocks of bluifh fchiftus; and to the beft of my memory it is very fine of the kind. There is alfo a confiderable quantity of it in difcontinuous ribs and maffes, in rocks of blue fchift, about three or four miles north of Callendar in Monteith, upon the fide of the high road which runs parallel to Lochleodunich, which I think alfo very fine. In fome places this fort of quartz is tinged with a flefh colour from the neighbourhood of iron, which renders it unfit for porcelain; but there is plenty to be found of a pure white in almoft all parts of Scotland, without any mineral tinge whatever. The kaolin is perhaps as plentiful in Scotland as the petuntfe, there being many extenfive lakes eafily drained, which contain a confiderable depth of it; and moreover, it is to be found in many places that have been lakes, which are now laid dry by accident. There is a quantity of kaolin about

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they are called *marbles*, and employed for the same purposes as the preceding (F).

2. Of kernels of jasper cemented by a jaspery substance. *Breccia jaspidea. Diaspro brecciato* of the Italians.

Of this kind specimens from Italy are seen in collections. A coarse jasper breccia is said to be found not far from Frejus in Provence in France.

3. Of siliceous pebbles, cemented by a jaspery substance,

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100 yards below the high road upon the south side of a bridge, about a mile and a half or two miles south of the inn of Aviemore in the Highlands. It lies beneath a stratum of peat bog, in a place which has been a lake, but is now drained by the river Spey cutting through one side of the mound which formed the lake.— There is more than one stratum of the kaolin in this place, and some of it is exceeding white, especially when blanched by the rain; and there is a white granite rock up the rivulet, at some distance above the bridge, the decomposition and dissolution of which is supposed to produce this fine and curious sediment. Several lakes in the Highlands of Scotland are nearly full of kaolin. One of them is situated in the country of Strathe-rig in Inverness-shire, less than a mile north of the public road, and upon the west side of the farm of Drimin. It is a pretty long lake, and there is a considerable depth of kaolin in it, which may be drained at a moderate expence; and, if I remember well, the granite rocks which surround it are pretty white and fine. If the kaolin originates from coloured granite, it is good for nothing, especially if it contains the least tinge of iron, because this will discolour and spoil the beauty of the porcelain; but wherever white granite is found composed of quartz, feldspath, and mica, without any admixture of shirl, and especially iron, the kaolin should be diligently sought after in that neighbourhood. Lochdoon, in Galloway, is said to contain a great quantity of kaolin. It was drained some years ago on the supposition of its containing shell marle; but on trying the substance contained in it, it was found not to be marle but kaolin. These substances may easily be mistaken for one another at first; but they are easily distinguished by trying them with acids, the marle readily effervescing with the weakest, and the kaolin not at all with the strongest acid liquors."

6. Grey composite granite is a very beautiful stone, and when broken looks as if composed of small fragments of various sizes and shapes, not unlike calve's-head jelly. When polished, the fragments appear as if set or inlaid in a fine pellucid or water-coloured matter. There is a single stratum of very curious composite granite, a little to the west of Lossiemouth, in the county of Moray, in Scotland of about six or eight feet thick. It is composed chiefly of grains and fragments of various bright and elegant colours, most of which are as large as pease and beans, all fine, hard, and semipellucid; there is about an eighth part of good lead ore in the composition of this stone, of the kind commonly called potter's ore; and it is likewise remarkable, that there is no other granite in that neighbourhood but this single stratum, all the strata above and below it being mostly a coarse, imperfect, grey sand-stone.

7. Granite of a loose friable texture, subject to spontaneous decomposition, and reduction to granite gravel. There is a remarkable rock of this kind near the Queen's-ferry in Scotland, on the road to Edinburgh, which appears in prodigious thick irregular strata. This rock seems to be composed chiefly of quartz, shirl, and some iron; and produces excellent materials for the high roads.

8. In many parts of the north of Scotland, in the Highlands, and in Galloway, there is found an excellent species of grey granite, composed chiefly of red and black coloured grains. This is a fine and very durable stone, very fit for all kinds of architecture.

In speaking of these stones, Mr Williams observes, that the finer and most elegant red granites, and the finest granite-like porphyries, so much resemble one another, that he does not attempt to distinguish them; and Scotland is remarkable for a great number and variety of them. "The elegant reddish granite of Bineves, near Fort William (says he), is perhaps the best and most beautiful in the world; and there is enough of it to serve all the kingdoms on earth, though they were all as fond of granite as ancient Egypt. There are extensive rocks of red granite upon the sea-shore to the west of the ferry of Ballachylish in Appin, and likewise at Strontian, as well as many other parts of Argyleshire. I have seen beautiful red granite by the road side, near Dingwall, and in several other parts of the north of Scotland, which had been blown to pieces with gunpowder, and turned off the fields. There are extensive rocks of reddish granite about Peterhead and Slains, and both of red and grey granite in the neighbourhood of Aberdeen. The hill of Cruffel in Galloway, and several lower hills and extensive rocks in that neighbourhood, are of red and grey granite, where there are great varieties of that stone, and many of them excellent. Upon the sea shore near Kinnedore, west of Lossiemouth, in Moray, there is a bed of stone about eight feet thick, which I think should be called a composite granite. It is composed of large grains, or rather small pieces of bright and beautiful stones of many different colours; and all the stony parts are exceedingly hard, and fit to receive the highest polish. About a sixth or eighth part of it also consists of lead ore, of that species called potter's ore. The separate stony parts composing this stratum are all hard, fine, solid, and capable of the most brilliant polish; and if solid blocks can be raised free from all cracks and blemishes, I imagine, from the beauty and variety of colours of the stony part, and the quantity of bright lead ore which is blended through the composition and body of the stone, that this would be a very curious and beautiful stone when polished."

(F) The stones called *Ludi Helmontii* or *Paracelsi*, have some similarity in their form to the *brecciæ, a. b.*; for they are composed of various lumps of a marly whitish-brown matter, separated into a great number of polygonous compartments, of various sizes, formed of a whitish-yellow crust of a red calcareous spar, some-

fubftance, or fomething like it. The plumpudding ftone of the Englifh; *Breccia filicea.* Its bafis, which at the fame time is the cement, is yellow; wherein are contained fingle flinty or agaty pebbles, of a grey colour or variegated. This is of a very elegant appearance when cut and polifhed: it is found in England and Scotland (G).

4. Of quartzofe kernels combined with an unknown cement. *Breccia quartzofa.*
5. Of kernels of feveral different kinds of ftones. *Breccia faxofa.*

a. Of kernels of porphyry, cemented by a porphyry or coarfe jafpery fubftance; *Breccia porphyrea.*
b. Of kernels of feveral faxa; *Breccia indeterminata.*
c. Of conglutinated kernels of fandftone; *Breccia arenacea.* This kind confifts of fandftone kernels, which have been combined a fecond time together.

The above mentioned brecciæ of themfelves muft demand the diftinctions here made between, but which perhaps may feem to be carried too far.

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times pyritous, which often rife a little above the external furface, and inclofe each of them on the infide. According to Bomare, the *ludus ftellatus helmontii*, found in the county of Kent, is covered with a kind of ftriated felenite refembling the zeolite. They are for the moft part of a globofe figure, feldom flat, but often convex on the outfide; and fometimes with a concave furface.

According to Wallerius, the *ludus helmontii* lofes by calcination about half of its weight; and, on being urged by fire, is melted into a black glaffy flag. It effervefces ftrongly with aqua-fortis, and this folution is of a yellow colour. But what feems very extraordinary, by adding to it fome oil of tartar *per deliquium*, bubbles are produced, from which a great number of flender black threads or filaments are produced, fticking like a cobweb to the fides and bottom of the veffel.

Thefe ftones are found quite feparate by themfelves, as well as various ftalagmites and cruftaceous bodies, on the ftrata of argillaceous earth, in various parts of Europe, chiefly in Lorrain, Italy, England (in the counties of Middlefex and Kent), and elfewhere.

Wallerius ranges the *ludus helmontii* among the *tophi*, in the Spec. 425. of his Syftem of Mineralogy. Paracelfus had attributed to thefe ftones a lithontriptic power, and Dr Grew fays that they are diuretic; but there is not the leaft proof of their really poffeffing fuch qualities.

(G) The breccia ftratum, or plumpudding-rock, exhibits a fingular appearance as it lies in the ground; being compofed of water-rounded ftones of all qualities and of all fizes, from fmall gravel up to large rounded ftones of feveral hundreds weight each; the interftices being filled up with lime and fand. It frequently alfo contains lime and iron. Sometimes it exhibits a grotefque and formidable appearance; containing many large bullets of various fizes and fhapes, without any marks of regular ftratification, but looking like one vaft mafs of bullets of unequal thicknefs; and in this manner frequently fwelled to the fize of a confiderable mountain. It is frequently cemented very ftrongly together; fo that parts of the hills compofed of it will frequently overhang in dreadful precipices, lefs apt to break off than other rocks in the fame fituation; one reafon for which, befides the ftrength of the cement, is, that the breccia, when compofed of bullets, is lefs fubject to fiffures and cutters than other rocks; being frequently found in one folid mafs of great extent and thicknefs. Some of the plumpudding-rocks are made up of fmaller parts, coming near to the fize of coarfe gravel. It is evident, however, that all the parts of the breccia, whether courfe or fine, have been rounded by agitation in water, as the rocks differ nothing in appearance from the coarfer and finer gravel found upon the beach of the fea, excepting only that the parts are ftrongly cemented together in the rocks, and are loofe upon the fhores of the ocean.

Some of the breccia is compofed of finely rounded ftones of various and beautiful colours, about the fize of plums or nuts, all very hard and fine. Were this fpecies fawed and polifhed, it would appear as beautiful and elegant as any ftone in Europe; much refembling mofaic work in fmall patterns.

In general, the breccia is regularly ftratified or not according to the fize of the component parts of the ftone. Such rocks as are compofed of round gravel and fmall bullets are generally very regular in their ftratification, while thofe which contain bullets fomewhat larger in fize are commonly difpofed in thick and coarfe beds, and fuch rocks as are made up of the largeft kind of bullets feldom fhow any marks of ftratification at all.

Among many other places in Scotland, where breccia or pudding-ftone abounds, there are extenfive rocks and high cliffs of it upon the fouth fhore at the weft end of the Pentland Frith, to the weftward of Thurfo in Caithnefs, which ftretch quite acrofs the county of Caithnefs into Sutherland; and in Sutherland as well as Caithnefs, this rock is of a rough contexture, and appears in pretty high hills, deep glens, overhanging rocks, and frightful precipices, to the weft of Brora, Dunrobin, and Dornoch, which gives it a grotefque and formidable appearance in that country. This range of breccia ftretches alfo quite through Sutherland, and likewife through Rofsfhire, the weft fide of Ferndonald, and Dingwall, where it exhibits the very fame phenomena as in Sutherland and Caithnefs. It continues the fame longitudinal line of bearing, which is nearly from north-eaft to fouth-weft, quite through the highland countries of Invernefs and Perthfhire; and it forms confiderable hills, and very high and rugged rocks, upon both fides of that beautiful piece of frefh water Lochnefs. Much of the ftone here, as well as in other places in this range, is compofed of large bullets; the rock is very hard and ftrong, and it hangs in frightful precipices upon both fides of the lake, through which rock Ge-

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far, ſince their particles are ſo big and plain as to be eaſily known from one another. Theſe ſtones are a proof both of the ſubverſions which the mountains in many centuries have undergone, and of ſome hidden means which nature makes uſe of in thus cementing different kinds of ſtones together. Any certain bigneſs for the kernels or lumps in ſuch compounds, before they deſerve the name of *breccia*, cannot be determined, becauſe that depends on a compariſon which every one is at liberty to imagine. In ſome places, the kernels of porphyry have a diameter of ſix feet, while in others they are no bigger than walnuts. Sometimes they have a progreſſive ſize down to that of a fine ſandſtone. Moſt of this kind of ſtone is fit for ornaments, though the workmanſhip is very difficult and coſtly.

B. Conglutinated ſtones of granules or ſands of different kinds. Sandſtone; *Lapis arenaceus.*

In this diviſion are reckoned thoſe which conſiſt of ſuch minute particles, that all of them cannot eaſily be diſcovered by the naked eye. The greateſt part, however, conſiſt of quartz and mica; which ſubſtances are the moſt fit to be granulated, without being brought to a powder.

1. Cemented by clay.
   - *a.* With an apyrous or refractory clay. This is of a looſe texture; but hardens, and is very refractory in the fire.
   - *b.* With common clay.
2. With lime; reſembles mortar made with coarſe ſand.
   - *a.* Conſiſting of tranſparent and greeniſh grains of quartz and white limeſtone.
   - *b.* Of no viſible particles. This is of a looſe texture, and hardens in the air.
3. With an unknown cement.
   - *a.* Looſe.
   - *b.* Harder.
   - *c.* Compact.
   - *d.* Very hard.
4. Cemented by the ruſt or ochre of iron. Is found in form of looſe ſtones at ſeveral places, and ought perhaps to be reckoned among the *mineræ arenaceæ* or ſand ores; at leaſt when the martial ochre makes any conſiderable portion of the whole.
5. Grit-ſtone. This is of greater or leſs hardneſs, moſtly of a grey, and ſometimes of a yellowiſh colour; compoſed of a ſiliceous and micaceous ſand, and rarely of a ſparry kind, with greater or leſſer particles cloſely compacted and united by an argillaceous cement. It gives ſome ſparks with ſteel, is indiſſoluble for the moſt part in acids, and vitriſiable in a ſtrong fire. It is uſed for millſtones and whetſtones, ſometimes for filtering ſtones and for building. *Fabroni.*

   N. B. The *argillaceous* grit has been before deſcribed, p. 89. col. 1.
6. Elaſtic. A ſingular ſpecies of ſandſtone, of which a ſpecimen was ſhown ſome years ago to the Royal Academy of Sciences at Paris by the Baron de Dietrich. It is flexible and elaſtic; and conſiſts of ſmall grains of hard quartz, that ſtrike fire with tempered ſteel, together with ſome micaceous mixture. The elaſticity ſeems to depend on the micaceous part, and ſoftneſs of the natural gluten between both. It is ſaid, that this elaſtic ſtone was found in Brazil, and brought to Germany by his excellency the Marquis de Lavradio.

   There are alſo two tables of white marble, kept in the palace Borgheſe at Rome, which have the ſame property. But the ſparry particles of their ſubſtance, though tranſparent, are rather ſoft; may be eaſily ſeparated with the nail, and efferveſce with aqua-fortis; and there is alſo in it a little mixture of ſmall particles of talc or mica. See *Journ. de Phyſ.* for Oct. 1784, p. 275. See alſo the article MARBLE (*Elaſtic.*)

C. Stones and ores cemented together; *Mineræ arenaceæ.*

1. Of larger fragments.
   - *a.* Mountain green, or *viride montanum cupri*, and pebbles cemented together, from Siberia.
   - *b.* Potters lead-ore, with limeſtone, ſlate-kernels, and ſhells.
   - *c.* Yellow or marcaſitical copper ore, with ſmall pebbles.
2. Of ſmaller pieces.
   - *a.* Potter's lead-ore with a quartzoſe ſand.
   - *b.* Mountain green with ſand from Siberia.
   - *c.* Cobalt ore with ſand.
   - *d.* Martial ochre with ſand.

Order II. MINERAL CHANGES, or PETRIFACTIONS.

THESE are mineral bodies in the form of animals or vegetables, and for this reaſon no others belong to this order than ſuch as have been really changed from the ſubjects of the other two kingdoms of nature.

I. Earthy changes; *Terræ larvatæ.*

A. Extraneous bodies changed into a lime ſubſtance, or calcareous changes; *Larvæ calcareæ.*

(1.) Looſe or friable. Chalky changes; *Cretæ larvatæ.*

a. In

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neral Wade cut a fine military road upon the ſouth ſide of the lake, at a great expence of time, labour, and gunpowder. Theſe rocks are ſeen ſtretching through the mountains of Stratherig into Badenoch, where it forms a remarkable rock and precipice called *Craigdow* or the *Black Rock*. The ſame range is again ſeen farther towards the ſouth-weſt, in ſeveral places to the ſouth of the Black Mount, and in the country of Glenorchy in Argyleſhire: and Mr Williams ſuppoſes, that the longitudinal line of this rock, ſo far as it has been juſt pointed out, is little leſs than 200 miles, and in ſome places it ſpreads eight or ten miles in what may be called the latitudinal line acroſs the bearing of the rocks.

a. In form of vegetables.
b. In form of animals.
1. Calcined or mouldered ſhells; *Humus conchaceus*.
(2.) Indurated; *Petrifacta calcarea*.
a. Changed and filled with ſolid limeſtone.
1. In form of animals.
2. In form of vegetables.
b. Changed into a calcareous ſpar; *Petrifacta calcarea ſpatoſa*.
1. In form of animals.
2. In form of vegetables.

B. Extraneous bodies changed into a flinty ſubſtance. Siliceous changes; *Larvæ ſiliceæ*. Theſe are, like the flint,
(1.) Indurated.
a. Changed into flints.
1. Carnelians in form of ſhells, from the river Tomm in Siberia.
2. Agat in form of wood. Such a piece is ſaid to be in the collection of Count Teſſin.
3. Coralloids of white flint, (*Millepora*.)
4. Wood of yellow flint.

C. Extraneous bodies changed into clay. Argillaceous changes; *Larvæ argillaceæ*.
A. Looſe and friable.
1. Of porcelain clay.
a. In form of vegetables.

A piece of white porcelain clay from Japan, with all the marks of the root of a tree, has been obſerved in a certain collection.

B. Indurated.
1. In an unknown clay.
a. In form of vegetables. *Oſteocolla*. It is ſaid to be changed roots of the poplar tree, and not to conſiſt of any calcareous ſubſtance.

A ſort of foſſile ivory is ſaid to be found, which has the properties of a clay; but it is doubtful if it has been rightly examined.

II. Saline extraneous bodies, or ſuch as are penetrated by mineral ſalts. *Corpora peregrina inſalita. Larvæ inſalitæ*.
A. With the vitriol of iron.
1. Animals.
a. Human bodies have been twice found in the mine at Falun in Dalarne; the laſt was kept a good many years in a glaſs-caſe, but began at laſt to moulder and fall to pieces.
2. Vegetables.
a. Turf, and
b. Roots of trees.

Theſe are found in water ſtrongly impregnated with vitriol. They do not burn with a flame, but only like coal in a ſtrong fire; neither do they decay in the air.

III. Extraneous bodies penetrated by mineral inflammable ſubſtances, or mineral phlogiſton.
A. Penetrated by the ſubſtance of pit-coals.
1. Vegetables, which commonly have been woods, or appertaining to them.
a. Fully ſaturated. *Gagas*, Jet. (See p. 104. col. 2.) The jet is of a ſolid ſhining texture.
b. Not perfectly ſaturated; *Mumia vegetabilis*. It is looſe; reſembles umber, and may be uſed as ſuch.

B. Penetrated by rock-oil or aſphaltum.
1. Vegetables.
a. Turf.

The Egyptian mummies cannot have any place here, ſince art alone is the occaſion that thoſe human bodies have in length of time been penetrated by the aſphaltum, in the ſame manner as has happened naturally to the wood in pit-coal ſtrata. See MUMMY.

C. Penetrated by ſulphur which has diſſolved iron, or by marcaſite and pyrites. *Pyrite impregnata. Petrifacta pyritacea*.
1. Animals.
a. Human.
b. Bivalves.
c. Univalves.
d. Inſects.

IV. Metals in form of extraneous bodies; *Larvæ metalliferæ*.
A. Silver; *Larvæ argentiferæ*.
(1.) Native.
a. On the ſurfaces of ſhells.
(2.) Mineraliſed with copper and ſulphur.
a. Fahlertz, or grey ſilver ore in form of ears of corn, &c. and ſuppoſed to be vegetables, are found in argillaceous ſlate at Frankenberg and Tahlitteren in Heſſe.

B. Copper; *Larvæ cupriferæ*.
(1.) Copper in form of calx.
a. In form of animals, or of parts belonging to them.
1. Ivory and other bones of the elephant. The Turcois or Turquoiſe; which is of a bluiſh green colour, and much valued in the eaſt.

At Simore in Languedoc bones of animals are dug, which during the calcination aſſume a blue colour; but it is not probable that the blue colour is owing to copper.

(2.) Mineraliſed copper, which impregnates extraneous bodies; *Cuprum mineraliſatum corpora peregrina ingreſſum*.
A. With ſulphur and iron. The yellow or marcaſitical copper ore that impregnates,
1. Animals.
a. Shells.
b. In form of fiſh.
B. With ſulphur and ſilver. Grey ſilver ore or fahlerts, like ears of corn, from the ſlate-quarries in Heſſe.

C. Changes into iron; *Larvæ ferriferæ*.
(1.) Iron in form of calx, which has aſſumed the place or the ſhape of extraneous bodies; *Ferrum calciforme corpora peregrina ingreſſum*.
a. Looſe; *Larvæ ochraceæ*.
1. Of vegetables.

Roots of trees, from the lake Langelma in Finland. See the acts of the Swediſh Academy of Sciences for the year 1742.

b. Indu-

b. Indurated; *Larvæ hæmatiticæ.*

1. Of vegetables.

(2.) Iron mineralifed, affuming the fhape of extraneous bodies.

a. Mineralifed with fulphur. Marcafite. *Larvæ pyritaceæ.*

V. Extraneous bodies decompofing, or in a way of deftruction; *Corpora peregrina in gradibus deftructionis confiderata.* Mould; *Humus.* Turf; *Turba.*

A. From animals. Animal-mould; *Humus animalis.*

1. Shells. *Humus conchaceus.*

2. Mould of other animals; *Humus diverforum animalium.*

B. Vegetable mould; *Humus vegetabilis.*

1. Turf; *Turba.*

a. Solid, and hardening in the air; *Turba folida aere indurefcens.* This is the beft of the kind to be ufed for fuel, and comes neareft to the pit-coals. It often contains a little of the vitriolic acid.

b. Lamellated turf; *Turba foliata.* This is in the firft degree of deftruction.

2. Mould of lakes; *Humus lacuftris.* This is a black mould which is edulcorated by water.

3. Black mould; *Humus ater.* This is univerfally known, and covers the furface of that loofe earth in which vegetables thrive beft.

Order III. Volcanic Products (H).

I. Slags; *Scoriæ vulcanorum.*

Slags are found in great abundance in many places of the world, not only where volcanoes yet exift, but likewife where no fubterraneous fire is now known: Yet, in Mr Cronftedt's opinion, they cannot be produced but by means of fire. Thefe are not properly to be called *natural*, fince they have marks of violence, and of the laft change that mineral bodies can fuffer without the deftruction of the world; nor are they *artificial*, according to the univerfally received meaning of this word. We cannot, however, avoid giving them a place here, efpecially after having admitted the petrifactions; and fhall therefore arrange the principal of them, according to their external marks.

A. Iceland agate; *Achates iflandicus niger.*

It is black, folid, and of a glaffy texture; but in thin pieces it is greenifh and femitranfparent like glafs-bottles, which contain much iron. The moft remarkable circumftance is, that fuch large folid maffes are found of it, that there is no poffibility of producing the like in any glafs-houfe.

It is found in Iceland, and in the ifland of Afcenfion: The jewellers employ it as an agate, though it is too foft to refift wear.

B. Rhenifh millftone; *Lapis molaris Rhenanus.*

Is blackifh-grey, porous, and perfectly refembles a fort of flag produced by mount Vefuvius. A variety of lava, according to Kirwan.

C. Pumice-ftone; *Pumex.*

It is very porous and bliftered, in confequence of which it is fpecifically very light. It refembles that frothy flag which is produced in our iron furnaces.

1. White.

2. Black.

The colour of the firft is perhaps faded or bleached, becaufe the fecond kind comes in that ftate from the laboratory itfelf, *viz.* the volcanoes.

D. Pearl-flag; *Scoriæ conftantes globulis vitreis conglomeratis.*

It is compounded of white and greenifh glafs particles, which feem to have been conglutinated while yet foft or in fufion. Found on the Ifle of Afcenfion.

E. Slag-fand or afhes; *Scoriæ pulverulentæ, cineres vulcanorum.*

This is thrown out from volcanoes in form of larger or fmaller grains. It may perhaps be the principle of the Terra Puzzolana; becaufe fuch an earth is faid at this time to cover the ruins of Herculaneum near Naples, which hiftory informs us was deftoyed by a volcano during an earthquake.

II. Lavas.

Lava has been generally underftood to denote the aggregate mafs of melted matters which flow out of the mouths, or burft out from the fides, of burning mountains. According to Mr Kirwan, however, lavas are the immediate produce of liquefaction or vitrification by the volcanic fires, and "fhould carefully be diftinguifhed from the fubfequent productions affected by the water either in a liquid or fluid ftate, which generally is ejected at the fame time." And of lavas, fo diftinguifhed, he defcribes feveral varieties. See the article Lava, in the order of the alphabet; where the nature, origin, kinds, and phenomena of lavas, are copioufly defcribed and explained.

III. Bafaltes.

This fort of ftone was by Cronftedt, in the firft edition of his Mineralogy, ranked among the garnet earths, and confounded with the fhoerls; an impropriety which was pointed out by Bergman in his *Sciagraphia*, fect. 120.—Mr Kirwan confiders bafaltes as an imperfect lava, and afcribes its origin both to fire and water. He defcribes it as found, either, 1. In opaque triangular or polyangular columns; which is the proper bafaltes: Or, 2. In amorphous maffes of different magnitudes; forming folid blocks, from the fmalleft fize to that of whole mountains: which kind is called *trapp*. See the detached article Basaltes (i); where its fpecies and varieties

(H) For the nature, hiftory, theory, &c. of volcanoes, fee the article Volcano.

(i) In that article, p. 46. col. 1. l. 9. *dele* the words, "The Englifh miners call it *cockle*, the German *fchoerl*."—P. 47. col. 2. l. 28. for "a kind of marble," read "a volcanic production." The *Lapis Lydius*, or Touchftone, mentioned in the fame paragraph, fhould have been fpecified to be of the fort called *Trapp*.

rieties are particularly defcribed, and different opinions ftated concerning its formation. See alfo the article TRAPP.—Some plaufible arguments againft the volcanic origin of bafaltes will be mentioned in the courfe of the fubjoined note (K), extracted from *Williams's Natural Hiftory of the Mineral Kingdom.*

(K) There is a great variety of bafaltes in Scotland, particularly of the grey kinds; fome of which are capable of the higheft degree of polifh. A good black kind is met with on the fouth fide of Arthur's Seat near Edinburgh, where it forms a fmooth perpendicular rock, with feveral of the columns broken off, and the fufpended pieces threatening to fall down upon the paffengers below. This ftone is capable of receiving a fine polifh; and, in the opinion of Mr Williams, would be fit for all forts of ornaments about fepulchral monuments. It will polifh to a bright and beautiful black, which will be unfading.

There is another kind, heavy and hard, of a black or blackifh-grey colour; of which great quantities have been carried from the Frith of Forth to pave the ftreets of London. This, for the moft part, is coarfely granulated in the infide, though fometimes the grain is pretty fine. Sometimes it is bright in the infide when broken. It is compofed of grains of quartz and fhirl of different fizes, and commonly contains fome iron. It always appears in thick, irregular, beds, fome of which are enormoufly thick; and feldom or ever equally fo: on the contrary, where it is found uppermoft, it frequently fwells into little hills of various fizes. Moft of the fmall iflands in the Frith of Forth are compofed of this kind of ftone; as well as fome hills in the neighbourhood of Inverkeithing and of Edinburgh.

The known characteriftic of the bafaltes is to form itfelf into balls, columns, and other regular figures. The columnar kind affumes a pentagonal, hexagonal, or heptagonal figure; but quadrangular columns are not common. They are all fmooth on the outfide, and lie parallel and contiguous to one another; fometimes perpendicular, fometimes inclining, in proportion to the pofition of the ftratum which is thus divided: If the ftratum lies horizontal, the columns are perpendicular; if inclining, the pillars alfo incline in exact proportion to the declivity of the ftrata, being always broken right acrofs the ftratum. Some are of one piece from top to bottom; others divided by one or more joints laid upon one another, which form a column of feveral parts. The rock called the *Giant's Caufeway* in Ireland is a pretty good fpecimen of the jointed columnar bafaltes: but there is a more beautiful fpecies above Hillhoufe lime-quarry, about a mile fouth of Linlithgow in Scotland; and a coarfer one near the toll-bar north fide of Queen's Ferry, and feveral other places in Fife. In fome places the bafaltes are formed into magnificent columns of great length; and in others afford an affemblage of fmall and beautiful pillars refembling a range of balluftrades or organ pipes. Some of the columns on the fouth fide of Arthur's Seat already mentioned are very long; and there are likewife magnificent columns of great length in the ifland of Egg, and others of the Hebrides. Thefe columns, when broken, are frequently of a black, or blackifh grey, in the infide; fome of them being compofed of fmall grains, which gives them an uniform and fmooth texture; but much of this fpecies of ftone has larger grains in its compofition, rough, fharp, and unequal, when broken. All the grains, however, are fine, hard, and bright; and the ftone in general is capable of a fine polifh.

The other fpecies of bafaltes which forms itfelf into diftinct maffes, affumes fometimes a quadrangular, fometimes an oval, globular, or indeterminate figure. They are found of all fizes from the fize of an egg to that of an houfe: but though they differ in fhape from the columnar bafaltes, they agree in almoft every other refpect; whence Mr Williams thinks that they are only to be accounted a variety of the columnar kind. It is common to fee one ftratum of the bafaltine rocks exhibiting, in one place, regular pillars or globes; and near thefe, very irregular ones, differing very little from the common cutters found in all rocks; and at no great diftance, the fame rock is found to run into one entire mafs, exhibiting no tendency to be broken or divided into any columns whatever. Of this the rock of Arthur's Seat is an inftance. Some of thefe only produce folid maffes of different figures and fizes; while others produce quantities of a fofter, friable, ftony matter, of the fame quality in which the hard maffes of different figures are found imbedded. Pretty good fpecimens of the fecond kind or variety of bafaltes are met with on the road-fide between Cramond bridge and the Queen's Ferry, and in feveral other places in the Lothians and in Fife.

The cruftated bafaltes are of two kinds; 1. Such as have the crufts more dry and friable than the internal parts; and, 2. Such as are dry and friable throughout the whole mafs.

The firft of thefe has not only a cruft of the friable matter adhering to it, but is likewife imbedded in a quantity of the fame. Our author has feen many quarries of this kind of bafaltes dug for the high roads, in which the quantity of foft friable matter greatly exceeded that of the hard maffes, and in which incrufted ftones of various fizes and fhapes appeared. In fuch quarries, fome of the largeft maffes have only a few coats of penetrable friable matter, furrounding a nucleus which varies in fize, but is uniformly hard throughout; and we fhall find other yolks in the fame quarry imbedded in the fofter matter, which, when broken, exhibit a neft of ftones including one another like the feveral coats of an onion. Thefe cruftated bafaltes which envelope one another are a curious fpecies of ftone. The feveral coats of furrounding matter differ nothing in quality from the ftones contained in them, and fome of the inner crufts are often very hard; but the nucleus within, though fmall, is always the hardeft. The decompofition by the weathering of the fofter matter found furrounding and enveloping the harder maffes of ftone in this and the fecond fpe-

cies of bafaltine rocks, has produced a phenomenon frequently met with in Great Britain, efpecially in Scotland, which greatly puzzles many. It is very common in low grounds, and upon fome moderate eminences, to fee a prodigious multitude of ftones of all fhapes and fizes, very hard, and pretty fmooth on the outfide. Thefe ftones are fometimes fo numerous and large, that it is often found impracticable to clear a field of them. Where thofe ftones are a fpecies of bafaltes, which they commonly are, and of the fecond fpecies of bafaltes defcribed above, they alway originate from a decompofition of the more foft or friable parts of thofe rocks, which moulder or fall away, and leave the harder ftones detached and fcattered about, and the decompofed matter diffolves by degrees, and becomes good corn mould.

Here Mr Williams takes occafion to conteft the opinion of thofe who think that ftones grow or vegetate like plants. He owns indeed that they increafe in bulk: but this, he fays, is only in fuch fituations as are favourable for an accretion of matter carried down and depofited by the water; in all other fituations they grow lefs and lefs. "Others (fays he) imagine, that thefe ftones (on which this extraneous matter has been depofited) were rolled about; that the afperities and fharp angles were by that means worn off; and that they were all at laft depofited as we fee them, by the waters of the univerfal deluge: and, having their obtufe fides and angles, as if they had been rounded by rolling in water, makes thefe gentlemen confident that they are right; and if we did not frequently find ftones exactly of the fame figure, fize, and quality in the rock, it would be very difficult to overthrow this hypothefis. I have taken great pains to inveftigate this point, having frequently examined circumftances; and never failed to difcover the ftratum of rock which thofe detached ftones originally belonged to. "The ftrata or beds of the feveral fpecies of bafaltes fpread as wide, and ftretch as far, as the other concomitant ftrata in the neighbourhood where they are found: but they often lie very flat, or with a moderate degree of declivity; and confequently, when the fofter and more friable matter found in the interftices of thefe rocks, which inclofes and binds the harder maffes in their native beds, is decompofed, the harder ftones muft then lie fcattered wide upon the face of the ground."

The fecond fpecies of the cruftated bafaltes, viz. that which is dry and friable throughout the whole mafs, is generally of a coarfe and granulated texture, and of all the various fhades of grey colours; from a rufty black to a light-coloured grey. This kind of cruftated bafaltes is developed when the maffes are either broken or in a ftate of decompofition; and there are maffes of it of all fizes and fhapes found in the rocks, refembling the fecond and third fpecies of the bafaltes; appearing alike fmooth on the outfide, with obtufe angles; in fhort, refembling the bafaltes in every refpect: but when they are expofed to the external air and weather for any confiderable time, the feveral incruftations decay, decompofe, and crumble down by degrees. When they quarry this fpecies of bafaltes for the roads, they are able to break and pound them fmall with eafe; but the harder fpecies are fo hard and cohefive, that they are with the greateft difficulty broken into fufficiently fmall parts.

Compofite bafaltes refembles the three laft fpecies, in figure, colour, and all other external appearances; being diftinguifhable from them only in the internal ftructure or grain of the ftone. It refembles fome of the granites, as confifting of much larger grains than the other bafaltes. Many of the larger grains in the compofite bafaltes are more than an eighth part of an inch over, and fome more than a fourth; appearing with fmooth flat furfaces, and of a tabulated texture, exactly refembling the quartzy grains fo commonly found in the compofition of moft of the granites. The chief, if not the only, diftinguifhable difference between the grains in each of them is the colour. They are evidently large grains of quartz, &c. which exhibit flat fhining furfaces in both. Thofe grains or fragments are commonly white, yellowifh, red, or black, in the compofition of moft of the granites; whereas they are often feen of a pale blue, or a bluifh grey colour, in the compofite bafaltes, and fome of them approaching to white. It is only in the *internal* ftructure, however, that thefe bafaltes have any refemblance to the granites; in all the external characters, they differ nothing from the reft of their own genus.

A fifth fpecies of bafaltes is indurated through the whole ftratum, folid and uniform through all its parts, and exhibiting only fuch cracks and fiffures or cutters as are commonly met with in other hard beds of ftones. Many beds of this fpecies are frequently met with in the coal-fields, and the miners are often obliged to fink through them in their coal-pits. "The Salifbury craigs at Edinburgh (fays our author) might be fingled out as a good example of this fpecies of ftone, were it not that part of the fame ftratum is formed into columns on Arthur's feat; though, I believe, this is no good exception, as it evidently appears that the beds of bafaltes which are formed into columns, glebes, &c. only affume thefe figures where they are expofed to the influence of the external air, or have but little cover of rock above them. When any of thofe beds ftrike deep under the cover of feveral other ftrata, they are not found in columns, &c. Nothing but an uniform mafs then appears, although the fame bed is regularly formed near the furface; which proves that the columnar and other bafaltes are formed by fhrinking and chapping.

"The ftrata of bafaltes fpread as wide, and ftretch as far in the longitudinal bearing, as the other different ftrata which accompany them in the countries where they are found. The rocks of bafaltes alfo are generally found in very thick ftrata; and that generally in places where no other rock is found above the bafaltes, the ftrata of it are often very unequal in thicknefs. But this, in general, is only in fituations where no other rock is found above it; for when it fairly enters into the furface of the earth, fo as to have other regular ftrata above it, which is feen in an hundred places in the Lothians, Fife, and other parts of Scotland, it then appears pretty equal in thicknefs, as equal as moft other beds of fuch great thicknefs are; and yet it is remarkable, that although moft of the ftrata of bafaltes are of great thicknefs, there are frequently thin

Appendix. VOLCANIC PRODUCTS

ſtrata of various kinds found both above and below it. We have numerous examples of this in all the parts of Scotland where baſaltes is found; as for inſtance, there are thin and regular ſtrata ſeen and quarried both above and below the thick bed of that rock in the Saliſbury craigs near Edinburgh. In the Bathgate hills, ſouth of Linlithgow, and in many other parts of Scotland, there are ſeveral ſtrata of baſaltes, and likewiſe of coal, limeſtone, freeſtone, and other concomitants of coal blended promiſcuouſly *ſtratum ſuper ſtratum*; and the baſalt is frequently found immediately above, and immediately below regular ſtrata of coal; of courſe baſaltes *is not the lava of volcanoes*. We can prove to ocular demonſtration, from the component parts, and from the ſituation, ſtretch, and bearing of the ſtrata of baſaltes, that they are real beds of ſtone, coeval with all the other ſtrata which accompany them; and are blended with them in the ſtructure of that part of the globe where they are found, as they dip and ſtretch as far every way as the other ſtrata found above and below them. If baſaltes, therefore, be a volcanic production, the other ſtrata muſt of neceſſity be ſo likewiſe. But how volcanoes ſhould produce coal, and how that coal ſhould come into contact with burning lava, is not a little problematical; or rather it is ſtrangely abſurd to imagine that burning lava can come into contact with coal without deſtroying it.

The regularly ſtratified quartzy white-mountain rock is ſcarce or rather not to be found in moſt parts of Britain. In the Highlands, however, it is very common; and in ſome places of them Mr Williams has ſeen it ſtratified as regularly as any of the ſand-ſtones, with other regular ſtrata of different qualities immediately above and below it; and ſometimes compoſing large and high mountains entirely of its own ſtrata. This ſtone is exceedingly hard, dry, and brittle, full of cracks and ſharp angles; the different ſtrata ſometimes moderately ſolid, but often naturally broken into ſmall irregular maſſes, with angles as ſharp as broken glaſs, and of an uniformly fine and granulated texture, reſembling the fineſt ſugar-loaf. There are large and high mountains of this ſtone in Roſsſhire and Invernefsſhire, which, in a clear day, appear at a diſtance as white as ſnow, without any ſort of vegetation on them except a little dry heath round the edge of the hill.

Minerva.

MINERVA, or PALLAS, in Pagan worſhip, the goddeſs of ſciences and of wiſdom, ſprung completely armed from Jupiter's brain; and on the day of her nativity it rained gold at Rhodes. She diſputed with Neptune the honour of giving a name to the city of Athens; when they agreed that whoſoever of them ſhould produce what was moſt uſeful to mankind, ſhould have that advantage. Neptune, with a ſtroke of his trident, formed a horſe; and Minerva cauſed an olive to ſpring from the ground, which was judged to be moſt uſeful, from its being the ſymbol of peace. Minerva changed Arachne into a ſpider, for pretending to excel her in making tapeſtry. She fought the giants; favoured Cadmus, Ulyſſes, and other heroes; and refuſed to marry Vulcan, chooſing rather to live in a ſtate of celibacy. She alſo deprived Tireſias of ſight, turned Meduſa's locks into ſnakes, and performed ſeveral other exploits.

Minerva is uſually repreſented by the poets, painters, and ſculptors, completely armed, with a compoſed but agreeable countenance, bearing a golden breaſt-plate, a ſpear in her right-hand, and her ægis or ſhield in the left, on which is repreſented Meduſa's head encircled with ſnakes, and her helmet was uſually entwined with olives.

Minerva had ſeveral temples both in Greece and Italy. The uſual victim offered her was a white heifer, never yoked. The animals ſacred to her were the cock, the owl, and the baſiliſk.

MINERVÆ *Caſtrum*, *Arx Minervæ*, *Minervium*, or *Templum Minervæ*, (anc. geogr.), a citadel, temple, and town on the Ionian ſea, beyond Hydrus; ſeen a great way out at ſea. Now *Caſtro*, a town of Otranto in Naples. E. Long. 19. 25. N. Lat. 46. 8.

MINERVÆ *Promontorium* (anc. geogr.), the ſeat of the Sirens, a promontory in the Sinus Paeſtanus, the ſouth boundary of Campania on the Tuſcan coaſt; ſo called from a temple of Minerva on it: ſituated to the ſouth of Surrentum, and therefore called *Surrentinum*. Now *Capo della Minerva*, on the weſt coaſt of Naples, over-againſt the iſland Capri.

Minervalia Mingrelia.

MINERVALIA, in Roman antiquity, feſtivals celebrated in honour of Minerva, in the month of March; at which time the ſcholars had a vacation, and uſually made a preſent to their maſters, called from this feſtival *Minerval*.

MINGRELIA, anciently COLCHIS, a part of Weſtern Georgia, in Aſia; bounded on the eaſt by Iberia, or *Georgia* properly ſo called; on the weſt, by the Euxine Sea; on the ſouth, by Armenia, and part of Pontus; and on the north, by Mount Caucaſus.

Colchis, or Mingrelia, is watered by a great many rivers; as the Corax, the Hippus, the Cyaneus, the Chariſtus, the Phaſis, where the Argonauts landed, the Abſarus, the Ciſſa, and the Ophis, all emptying themſelves into the Euxine Sea. The Phaſis does not ſpring from the mountains in Armenia, near the ſources of the Euphrates, the Araxes, and the Tigris, as Strabo, Pliny, Ptolemy, Dionyſius, and after them Arrian, Reland, Calmet, and Sanſon, have falſely aſſerted; but riſes in Mount Caucaſus; and flows not from ſouth to north, but from north to ſouth, as appears from the map of Colchis or Mingrelia in Thevenot's collection, and the account which Sir John Chardin gives of that country. This river forms in its courſe a ſmall iſland called alſo *Phaſis*; whence the pheaſants, if Iſidorus is to be credited, were firſt brought to Europe, and thence called by the Greeks *Phaſiani*. The other rivers of Colchis are conſiderable.

The whole kingdom of Colchis was in ancient times very pleaſant and fruitful, as it is ſtill where duly cultivated; abounded in all the neceſſaries of life; and was enriched with many mines of gold, which gave occaſion to the fable of the Golden Fleece and the Argonautic expedition ſo much celebrated by the ancients.

Mingrelia.

Sir John Chardin tells us, that this country extends above 100 miles in length and 60 in breadth; being not near so extensive as the ancient Colchis, which reached from the frontiers of Iberia or Georgia Proper, westward to the Palus Mæotis: that it is beautifully diversified with hills, mountains, valleys, woods, and plains, but badly cultivated: that there are all the kinds of fruits which are found in England, growing wild, but tasteless and insipid for want of culture: that, if the natives understood the art of making wines, those of this country would be the finest in the world: that there are many rivers which have their source in Mount Caucasus, particularly the Phasus, now called the *Rione:* that the country abounds in beeves, hogs, wild boars, stags, and other venison; and in partridges, pheasants, and quails: that falcons, eagles, pelicans, lions, leopards, tigers, wolves, and jackals, breed on Mount Caucasus, and sometimes greatly annoy the country: that the people are generally handsome, the men strong and well made, and the women very beautiful; but both sexes very vicious and debauched: that they marry their nieces, aunts, or other relations, indifferently; and take two or three wives if they please, and as many concubines as they will: that they not only make a common practice of selling their children, but even murder them, or bury them alive, when they find it difficult to bring them up: that the common people use a sort of paste, made of a plant called *gom*, instead of bread; but that of the better sort consists of wheat, barley, or rice: that the gentry have an absolute power over their vassals, which extends to life, liberty, and estate: that their arms are the bow and arrow, the lance, the sabre or broad-sword, and the buckler: that they are very nasty; and eat sitting cross-legged upon a carpet, like the Persians; but the poorer sort upon a mat or bench, in the same posture: that the country is very thin of inhabitants, no less than 12,000 being supposed to be sold yearly to the Turks and Persians: that the principal commodities exported from it are, honey, wax, hides, castor, martin-skins, flax-seed, thread, silk, and linen-cloth; but that there are no gold or silver mines now, and very little money: that the revenue of the prince or viceroy amounts to about 20,000 crowns *per annum:* that the inhabitants call themselves *Christians;* but that both they and their priests are altogether illiterate, and ignorant of the doctrines and precepts of Christianity: that their bishops are rich, have a great number of vassals, and are clothed in scarlet and velvet: and that their service is according to the rites of the Greek church, with a mixture of Judaism and Paganism.

The cities of most note in this country in ancient times were Pityus; Dioscurias, or Dioscorias, which was so called from Castor and Pollux, two of the Argonauts, by whom it is supposed to have been founded, and who in Greek are styled *Dioscuroi*, at present known by the name of *Savatapoli;* Aea on the Phasis, supposed to be the same as Hupolis; *Phasis*, so called from the river on which it stood; Cyta, at the mouth of the river Cyaneus, the birth-place of the famous Medea, called from thence, by the poets, *Cytæis;* Saracæ, Zadris, Surium, Madia, and Zolissa. As for modern cities, it does not appear that there are any here considerable enough to merit a description; or, if there are, they seem to be little, if at all, known to Europeans.

Minho, Miniature.

MINHO, a great river in Spain, which taking its rise in Galicia, divides that province from Portugal, and falls into the Atlantic at Caminha.

MINIATURE, in a general sense, signifies representation in a small compass, or less than the reality.

MINIATURE-PAINTING;

A DELICATE kind of painting, consisting of little points or dots; usually done on vellum, ivory, or paper, with very thin, simple water-colours. —The word comes from the Latin *minium*, "red-lead;" that being a colour much used in this kind of painting. The French frequently call it *mignature*, from *mignon*, "fine, pretty," on account of its smallness and delicacy: and it may be ultimately derived from μικρος "small."

Miniature is distinguished from other kinds of painting by the smallness and delicacy of its figures and faintness of the colouring; on which account it requires to be viewed very near.

SECT. I. *Of Drawing and Designing.*

To succeed in this art, a man should be perfectly skilled in the art of designing or drawing: but as most people who affect the one, know little or nothing of the other, and would have the pleasure of painting without giving themselves the trouble of learning to design (which is indeed an art that is not acquired without a great deal of time, and continual application), inventions have been found out to supply the place of it; by means of which a man designs or draws, without knowing how to design.

The first is chalking: that is, if you have a mind to do a print or design in miniature, the backside of it, on another paper, must be blackened with small-coal, and then rubbed very hard with the finger wrapped in a linen cloth: afterwards the cloth must be lightly drawn over the side so blackened that no black grains may remain upon it to soil the vellum you would paint upon; and the print or draught must be fastened upon the vellum with four pins, to keep it from shifting. And if it be another paper that is blackened, it must be put between the vellum and the print, or draught, with the blackened side upon the vellum. Then, with a blunted pin or needle, you must pass over the principal lines or strokes of the print, or draught, the contours, the plaits of the drapery, and over every thing else that must be distinguished; pressing so hard, that the strokes may be fairly marked upon the vellum underneath.

Copying by squares is another convenient method for such as are but little skilled in the art of designing, and would copy pictures, or other things, that cannot be chalked. The method is this: The piece must be divided

SUPPLEMENT

TO THE THIRD EDITION OF THE

ENCYCLOPÆDIA BRITANNICA,

OR, A

DICTIONARY

OF

ARTS, SCIENCES,

AND

MISCELLANEOUS LITERATURE.

IN TWO VOLUMES.

Illuſtrated with Fifty Copperplates.

By GEORGE GLEIG, LL.D. F.R.S. Edin.

NON IGNORO, QUÆ BONA SINT, FIERI MELIORA POSSE DOCTRINA, ET QUÆ NON OPTIMA, ALIQUO MODO ACUI TAMEN, ET CORRIGI POSSE.——*Cicero.*

VOL. II.

THE SECOND EDITION, WITH IMPROVEMENTS.

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BY *JOHN BROWN*, ANCHOR CLOSE, EDINBURGH.

1803.

Meninſki, Merchetta.

words are added, from Wankuli and Ferhengi, the beſt Arabic and Perſic lexicographers whom the Eaſt has produced; and from Herbelot are inſerted the names of kingdoms, cities, and rivers, as well as phraſes in common uſe among the Turks, &c. *Diminiſhed*, becauſe many uſeleſs ſynonyma are omitted, which rather puzzled than aſſiſted the ſtudent; as well as all the French, Poliſh, and German interpretations, the Latin being conſidered as ſufficient for all men of learning. *Amended*, with reſpect to innumerable typographical errors; which, however, from a work of this nature, no care can perhaps altogether exclude. The other works of Meninſki were occaſioned chiefly by a violent conteſt between him and a man named J. B. Podeſta, in which much acrimony was employed on both ſides. Theſe it is hardly worth while to enumerate, but they may all be ſeen in the account of his life from which this article is taken (A). It ſhould be obſerved, however, that in 1674, Podeſta publiſhed a book, intitled, "Prodromus novi linguarum orientalium collegii, juſſu Aug. &c. erigendi, in Univ. Viennenſi;" to which Meninſki oppoſed, 2. "Meninſkii Antidotum in Prodromum novi ling. orient. collegii, &c." 4to. But ſuch was the credit of his antagoniſt in the univerſity, that ſoon after there came out a decree in the name of the rector and conſiſtory, in which that antidote of Meninſki's is proſcribed and prohibited, for ſix ſpecific reaſons, as impious and infamous. Meninſki was defended againſt this formidable attack by a friend, in a ſmall tract, intitled, "Veritas defenſa, ſeu juſtitia cauſæ Dn. F. de M. M. [Meninſki] contra infame decretum Univerſitatis Viennenſis, Anno 1674, 23 Novembris, &c. ab Amico luci expoſita, Anno 1675," in which this friend expoſes, article by article, the falſehood of the decree, and exclaims ſtrongly againſt the arts of Podeſta. This tract is in the Britiſh Muſeum. Podeſta was oriental ſecretary to the emperor, and profeſſor of thoſe languages at Vienna; but is deſcribed in a very ſatirical manner by the defender of Meninſki. "Podeſta, natura Semi-Italus, ſtatura nanus, cæcutiens, balbus, imo bardus repertus, aliiſque vitiis ac ſtultitiis plenus, adeoque ad diſcendas linguas orientales inhabilis." A liſt of the works of Podeſta is, however, given by the late editors of Meninſki.

MERCHETTA, or *Marchetta Mulierum*, is commonly ſuppoſed to have been a right which, during the prevalence of the feudal ſyſtem, the lord had of paſſing the firſt night after marriage with his female villain. This opinion has been held by the greater part of our antiquarians; and we have adopted it in our hiſtory of Scotland publiſhed in the *Encyclopædia*. It appears, however, to be a miſtake. That there was a cuſtom called *merchetta mulierum*, which prevailed not only in England, Scotland, Wales, and the iſle of Guernſey, but alſo on the continent, is indeed a fact unqueſtionable; but Mr Aſtle has clearly proved, that, inſtead of being an adulterous connection, the *merchetta* was a compact between the lord and his vaſſal for the redemption of an *offence* committed by that vaſſal's *unmarried* daughter. He admits, however, that it denoted likewiſe a fine paid by a *ſokeman* or a *villain* to his lord for a licence to marry his daughter to a free man; and that if the vaſſal gave her away without obtaining ſuch a licence, he was liable to pay a heavier fine. He quotes two authorities in ſupport of his opinion from Bracton; one of which we ſhall tranſcribe, as being alone complete evidence.

Archæologia, vol. xii.

Meridian.

"Ric. Burre tenet unum meſuagium et debet telliagium ſectam curiæ, et *merchet*, hoc modo, *quod ſi maritare voluerit filiam ſuam cum quodam libero homine, extra villam, faciet pacem domini pro maritagio, et ſi eam maritaverit alicui cuſtumario villæ, nihil debuit pro maritagio.*"

"The probable reaſon of the cuſtom (ſays Mr Aſtle) appears to have been this. Perſons of low rank, reſiding on an eſtate, were either *aſcripti glebæ*, or were ſubjected to ſome ſpecies of ſervitude ſimilar to the *aſcripti glebæ*. They were bound to reſide on the eſtate, and to perform ſeveral ſervices to the lord. As women neceſſarily followed the reſidence of their huſbands, the conſequence was, that when a woman of low rank married a ſtranger, the lord was deprived of part of his live ſtock; he therefore required a fine to indemnify him for the loſs of his property," Further particulars on the *merchetta* are to be found in the Appendix to vol. 1ſt of *Sir David Dalrymple's Annals of Scotland.*

MERIDIAN Line, an arch or part of the meridian of the place, terminated each way by the horizon. Or, a meridian line is the interſection of the plane of the meridian of the place with the plane of the horizon, often called a north and ſouth line, becauſe its direction is from north to ſouth.

In the article Astronomy (*Encycl.*), n° 376. and 377. we have given two methods of drawing a meridian line; but it may be proper to add, in this place, the following improvement of the former of theſe from Dr Hutton's Mathematical Dictionary. "As it is not eaſy (ſays the Doctor) to determine preciſely the extremity of the ſhadow, it will be beſt to make the ſtile flat at the top, and to drill a ſmall hole through it, noting the lucid point projected by it on the ſeveral concentric circles, inſtead of marking the extremity of the ſhadow itſelf on theſe circles."

We ſhall give another method of drawing a meridian line from the ſame valuable dictionary.

"Knowing the ſouth quarter pretty nearly, obſerve the altitude FE of ſome ſtars on the eaſt ſide of it, and not far from the meridian HZRN: then, keeping the quadrant firm on its axis, ſo as the plummet may ſtill cut the ſame degree, direct it to the weſtern ſide of the meridian, and wait till you find the ſtar has the ſame altitude as before, as *fe*. Laſtly, biſect the angle EC*e*, formed by the interſection of the two planes in which the quadrant has been placed at the time of the two obſervations, by the right line HR, which will be the meridian ſought.

Plate XXXVI.

Magnetical Meridian, is a great circle paſſing thro' or by the magnetical poles; to which meridians the magnetical needle conforms itſelf. See Magnetism, *Suppl.*

MESO-

(A) We have taken this article from the Biographical Dictionary; the editors of which took it from the life of Meninſki prefixed to the new edition of his great work.

Meso-Logarithm || Mills.

MESO-LOGARITHM, a term ufed by Kepler to fignify the logarithms of the cofines and cotangents.

MESURATA, a fea port of the kingdom of Tripoli, in Africa. A caravan proceeds from this place to Fezzan, and other interior parts toward the fouth of Africa. It is 260 miles north of Mourzook. E. Lon. 15. 5. N. Lat. 31. 3.

METALLIC TRACTORS. See PERKINISM in this *Suppl.*

METONIC CYCLE, called alfo the *Golden Number*, and *Lunar Cycle*, or *Cycle of the Moon*, that which was invented by Meton the Athenian; being a period of 19 years. See CYCLE, *Encycl.*

MHA RAJAH, the higheft title of Hindoos.

MICROCOUSTICS, or MICROPHANES, inftruments contrived to magnify fmall founds, as microfcopes do fmall objects.

MICROCOSMIC SALT. See CHEMISTRY-*Index*, *Suppl.*

MIDDLE LATITUDE, is half the fum of two given latitudes; or the arithmetical mean, or the middle between two parallels of latitude. Therefore,

If the latitudes be of the fame name, either both north or both fouth, add the one number to the other, and divide the fum by 2; the quotient is the middle latitude, which is of the fame name with the two given latitudes. But,

If the latitudes be of different names, the one north and the other fouth; fubtract the lefs from the greater, and divide the remainder by 2, fo fhall the quotient be the middle latitude, of the fame name with the greater of the two.

MIDSUMMER-DAY, is held on the 24th of June, the fame day as the nativity of St John the Baptift is held.

MILK, or MILKYET, property in Bengal.

MILLS of various kinds are defcribed in the article MECHANICS (*Encycl.*); and he who fhall ftudy that article, together with *Water-Works*, and MACHINERY, in this *Supplement*, will have a fufficient knowledge of the principles upon which mills muft be conftructed, fo as that they may produce their proper effects. The fubject is introduced into this place merely to put it into the power of our countrymen to adopt, if they fhall think fit, the improvements which have been made in the machinery of flour mills in America.

The chief of thefe confift in a new application of the fcrew, and the introduction of what are called elevators, the idea of which was evidently borrowed from the chain-pump. The fcrew is made by fticking fmall thin pieces of board, about three inches long and two wide, into a cylinder, fo as to form the fpiral line. This fcrew is placed in a horizontal pofition, and by turning on its axis it forces wheat or flour from one end of a trough to the other. For inftance, in the trough which receives the meal immediately coming from the ftones, a fcrew of this kind is placed, by which the meal is forced on, to the diftance of fix or eight feet, perhaps, into a refervoir; from thence, without any manual labour, it is conveyed to the very top of the mill by the elevators, which confift of a number of fmall buckets of the fize of tea cups, attached to a long band that goes round a wheel at the top, and another at the bottom of the mill. As the band revolves round the wheels, thefe buckets dip into the refervoir of wheat or flour below, and take their loads up to the top, where they empty themfelves as they turn round the upper wheel. The elevators are inclofed in fquare wooden tubes, to prevent them from catching in any thing, and alfo to prevent duft. By means of thefe two fimple contrivances, no manual labour is required from the moment the wheat is taken to the mill till it is converted into flour, and ready to be packed, during the various proceffes of fcreening, grinding, fifting, &c.

That this is a confiderable improvement is obvious; and we are not without hopes that it may be adopted. The licentioufnefs of an Englifh mob has indeed perfecuted an Arkwright, expelled the inventor of the fly-fhuttle from his native country, and by fuch conduct prevented the re-erection of the Albion mills, and the general eftablifhment of faw-mills through the kingdom; but their fovereignty perhaps will not be roufed by fo eafy and fimple a contrivance as this to leffen the quantity of manual labour. For an account of the Dutch oil-mill, which was fomehow omitted in its proper place in the *Encyclopædia*, fee OIL-MILL in this *Supplement*.

MINERALOGY

1 Definition.

IS a fcience, the object of which is the defcription and arrangement of *inorganic bodies* or *minerals*; or of *all* the bodies which belong to our globe, excepting *animal* and *vegetable* fubftances.

Since the publication of the article MINERALOGY, *Encycl.* fcarcely a fingle day has paffed without the difcovery of fome new mineralogical fact, or the detection of fome old and unfufpected error. Thefe improvements cannot be overlooked in the prefent *Supplement*. But they are fo numerous in every part of the fcience, that we can hardly notice them without giving a pretty complete view of the prefent ftate of mineralogy. This will fcarcely occupy more room, and muft be much more ufeful as well as entertaining, than an undigefted mafs of annotations and remarks. We undertake this tafk the more readily, becaufe in the article MINERALOGY in the *Encyclopædia*, the improvements of Mr Werner and his difciples, to which the fcience is indebted for a great part of its prefent accuracy, have been entirely overlooked.

The object of mineralogy is twofold. 1. To *defcribe* every mineral with fo much accuracy and precifion, that it may be eafily diftinguifhed from every other mineral. 2. To *arrange* them into a fyftem in fuch a manner that every mineral may be eafily referred to its proper place, and that a perfon may be able, merely by the help of the fyftem, to difcover the *name* of any mineral whatever. When thefe two objects are accomplifhed, mineralogy, 2 Object.

Description of Minerals. neralogy, strictly so called, is completed. But were we to stop here, the utility of the science, if it would be entitled to the name of science, could hardly be considered as very great. We must therefore apply *chemistry* to discover the ingredients of which minerals are composed, and to detect, if possible, the laws which these ingredients have observed in their combination. Thus we shall really extend our knowledge of inorganic nature, and be enabled to apply that knowledge to the improvement of almost every art and manufacture.

3 Division of the article. Mineralogy naturally divides itself into three parts. The *first* treats of the method of describing minerals; the *second*, of the method of arranging them; and the *third* exhibits them in a system described and arranged according to the rules laid down in the two first parts. These three parts shall be the subjects of the following chapters; and we shall finish the article with a chapter on the chemical analysis of minerals.

Chap. I. Of the Description of Minerals.

Nothing, at first sight, appears easier than to describe a mineral, and yet, in reality, it is attended with a great deal of difficulty. The mineralogical descriptions of the ancients are so loose and inaccurate, that many of the minerals to which they allude cannot be ascertained; and consequently their observations, however valuable in themselves, are often, as far as respects us, altogether lost. It is obvious, that to distinguish a mineral from every other, we must either mention some peculiar property, or a collection of properties, which exist together in no other mineral. These properties must be described in terms rigidly accurate, which convey precise ideas of the very properties intended, and of no other properties. The smallest deviation from this would lead to confusion and uncertainty. Now it is impossible to describe minerals in this manner, unless there be a peculiar term for each of their properties; and unless this term be completely understood. Mineralogy therefore must have a language of its own; that is to say, it must have a *term* to denote every mineralogical property, and each of these terms must be accurately defined. The language of mineralogy was invented by the celebrated Werner of Freyberg, and first made known to the world by the publication of his treatise on *The External Characters of Minerals*. Of this language we shall give a view in the following general description of the properties of minerals (A).

4 Properties of minerals. The properties of minerals may be divided into two classes. *1st*, Properties discoverable without destroying the texture of the mineral; *2d*, Properties resulting from the action of other bodies on it. The first class has, by Werner and his disciples, been called *external* properties, and by some French writers *physical;* the second class has been called *chemical.*

The *external* properties may be arranged under the following heads:

External Characters.

1. Figure,	8. Ductility,	14. Sound,
2. Surface,	9. Fracture,	15. Smell,
3. Transparency,	10. Texture,	16. Taste,
4. Colour,	11. Structure,	17. Gravity,
5. Scratch,	12. Fragments,	18. Magnetism,
6. Lustre,	13. Feel,	19. Electricity.
7. Hardness,		

I. By figure is meant the shape or form which a mineral is observed to have. The *figure* of minerals is either *regular*, *particular*, or *amorphous*. 1. Minerals which assume a regular figure are said to be crystallized *. The *sides* of a crystal are called *faces;* the sharp line formed by the inclination of two faces is called an *edge;* and the corner, or angle, formed by the meeting of several edges in one point, is called a *solid angle*, or simply *an angle*. Thus a cube has six faces, twelve edges, and eight angles. 2. Some minerals, though not crystallized, affect a *particular* figure. These particular figures are the following: *Globular*, like a globe; *oval*, like an oblong spheroid; *ovate*, like an egg; *cheese-shaped*, a very flattened sphere; *almond-shaped*, like an almond; *centicular*, like a double convex lense, compressed and gradually thinner towards the edges; *cuneiform*, like a wedge; *nodulous*, having depressions and protuberances like a potatoe; *botryoidal*, like grapes closely pressed together; *dentiform*, longish and tortuous, and thicker at the bottom than the top; *wireform*, like a wire; *capillary*, like hair, finer than the preceding; *retiform*, threads interwoven like a net; *dentritic*, like a tree, having branches issuing from a common stem; *shrubform*, branches not arising from a common stem; *coraloidal*, branched like coral; *stalactical*, like isicles; *clavated*, like a club, long, and thicker at one end than another; *fasciform*, long straight cylindrical bodies, united like a bundle of rods; *tubular*, cylindrical and hollow. 3. When minerals have neither a regular nor particular shape, they are said to be *amorphous*. 5 Figure.

* See Chemistry, Part III. ch. iv. *Suppl.*

6 Surface. II. By surface is meant the appearance of the external surface of minerals. The *surface* is either *uneven*, composed of small unequal elevations and depressions; *scabrous*, having very small *sharp* and rough elevations, more easily felt than seen; *drusy*, covered with very minute crystals; *rough*, composed of very minute *blunt* elevations, easily distinguishable by the feel; *scaly*, composed of very minute thin scale-like leaves; *smooth*, free from all inequality or roughness; *specular*, having a smooth polished surface like a mirror; or *streaked*, having elevated, straight, and parallel lines. This last character is confined to the *surface* of crystals. The *streaks* are either *transverse; longitudinal; alternate*, in different directions on different faces; *plumose*, running from a middle rib; or *decussated*, crossing each other.

7 Transparency. III. By transparency is meant the proportion of light which minerals are capable of transmitting. They are *transparent* or *pellucid* when objects can be seen distinctly through them; *diaphanous*, when objects are seen

(A) The fullest account of Werner's external characters which we have seen in the English language, has been given by Dr Townson in his *Philosophy of Mineralogy*. We have availed ourselves of this book, in order to exhibit some of the latest improvements of Werner and his disciples. The reader may also consult *Werner's Treatise*, published at Leipsic in 1774; or the *French translation* published at Dijon in 1790. See also *Romé de Lisle. Des Caracters Exterieur des Mineraux.* And *Hauy Jour. d'Hist. Nat.* II. 56.

External Characters.

seen through them indistinctly; *subdiaphanous*, when light passes but in so small a quantity that objects cannot be seen through them (B); *opaque*, when no light is transmitted.

When opaque minerals become transparent in water, they are called *hydrophanous*. When objects are seen double through a transparent mineral, it is said to *refract doubly*.

8 Colour. IV. The colours of minerals may be reduced to eight classes.

1. *Whites*.

Snow white. Pure white.

Reddish white. White with a light tint of red.

Yellowish white. White with a light tint of yellow.

Silver white. Yellowish white with a metallic lustre.

Greyish white. White with a light tint of black.

Greenish white. White with a light tint of green.

Milk white. White with a light tint of blue.

Tin white. Milk white of a metallic lustre.

2. *Greys*.

Bluish grey. Grey with a little blue.

Lead grey. Bluish grey with a metallic lustre.

Pearl grey. Light grey with a slight mixture of violet blue.

Smoke grey. Dark grey with a little blue and brown.

Greenish grey. Light grey tinged with green.

Yellowish grey. A light grey tinged with yellow.

Steel grey. A dark grey with a light tint of yellow and a metallic lustre.

Black grey. The darkest grey with a tint of yellow.

3. *Blacks*.

Greyish black. Black with a little white.

Brownish black. Black with a tint of brown.

Black. Pure black.

Iron black. Pure black with a small mixture of white and a metallic lustre.

Bluish black. Black with a tint of blue.

4. *Blues*.

Indigo blue. A dark blackish blue.

Prussian blue. The purest blue.

Azure blue. A bright blue with scarce a tint of red.

Smalt blue. A light blue.

Violet blue. A mixture of azure blue and carmine.

Lavender blue. Violet blue mixed with grey.

Sky blue. A light blue with a slight tint of green.

5. *Greens*.

Verdigris green. A bright green of a bluish cast.

Seagreen. A very light green, a mixture of verdigris green and grey.

Beryl green. The preceding, but of a yellowish cast.

Emerald green. Pure green.

Grass green. Pure green with a tint of yellow.

Apple green. A light green formed of verdigris green and white.

Leek green. A very dark green with a cast of brown.

Blackish green. The darkest green, a mixture of leek green and black.

Pistachio green. Grass green, yellow and a little brown.

Olive green. A pale yellowish green with a tint of brown.

Asparagus green. The lightest green, yellowish with a little brown and grey.

6. *Yellows*.

Sulphur yellow. A light greenish yellow.

Brass yellow. The preceding, with a little less green and a metallic lustre.

Lemon yellow. Pure yellow.

Gold yellow. The preceding with a metallic lustre.

Honey yellow. A deep yellow with a little reddish brown.

Wax yellow. The preceding, but deeper.

Pyritaceous. A pale yellow with grey.

Straw yellow. A pale yellow, a mixture of sulphur yellow and reddish grey.

Wine yellow. A pale yellow with a tint of red.

Ochre yellow. Darker than the preceding, a mixture of lemon yellow with a little brown.

Isabella yellow. A pale brownish yellow, a mixture of pale orange with reddish brown.

Orange yellow. A bright reddish yellow, formed of lemon yellow and red.

7. *Reds*.

Aurora red. A bright yellow red, a mixture of scarlet and lemon yellow.

Hyacinth red. A high red like the preceding, but with a shade of brown.

Brick red. Lighter than the preceding; a mixture of aurora red and a little brown.

Scarlet red. A bright and high red with scarce a tint of yellow.

Copper red. A light yellowish red with the metallic lustre.

Blood red. A deep red, a mixture of crimson and scarlet.

Carmine red. Pure red verging towards a cast of blue.

Cochineal red. A deep red; a mixture of carmine with a little blue and a very little grey.

Crimson red. A deep red with a tint of blue.

Flesh red. A very pale red of the crimson kind.

Rose red. A pale red of the cochineal kind.

Peach blossom red. A very pale whitish red of the crimson kind.

Mordoré. A dark dirty crimson red; a mixture of crimson and a little brown.

Brownish red. A mixture of blood red and brown.

8. *Browns*.

Reddish brown. A deep brown inclining to red.

Clove brown. A deep brown with a tint of carmine.

Yellowish brown. A light brown verging towards ochre yellow.

Umber brown. A light brown, a mixture of yellowish brown and grey.

Hair brown. Intermediate between yellow brown and clove brown with a tint of grey.

Tombac brown. A light yellowish brown, of a metallic lustre, formed of gold yellow and reddish brown.

Liver

(B) After Mr Kirwan, we have denoted these three degrees of transparency by the figures 4, 3, 2. When a mineral is subdiaphanous only at the edges, that is denoted by the figure 1. Opacity is sometimes denoted by 0.

External Characters. Liver brown. A dark brown; blackish brown with a tint of green.

Blackish brown. The darkest brown.

Colours, in respect of intensity, are either *dark*, *deep*, *light*, or *pale*. When a colour cannot be referred to any of the preceding, but is a mixture of two, this is expressed, by saying, that the prevailing one *verges* towards the other, if it has only a small tint of it; *passes* into it, if it has a greater.

9 Streak. V. By the SCRATCH or STREAK, is meant the mark left when a mineral is scratched by any hard body, as the point of a knife. It is either *similar*, of the same colour with the mineral; or *dissimilar*, of a different colour.

10 Lustre. VI. LUSTRE, is the gloss, or brightness which appears on the external surface of a mineral, or on its internal surface when fresh broken. The first is called *external*, the second *internal* lustre. Lustre is either *common*, that which most minerals possess; *silky*, like that of silk or mother-of-pearl; *waxy*, like that of wax; *greasy*, like that of grease; or *metallic*, like that of metals.

As to the degree, the greatest is called *splendent*, the next *shining*, the third *dullish*; and when only a few scattered particles shine, the lustre is called *dull* (c).

11 Hardness. VII. We have used figures to denote the comparative HARDNESS of bodies; for an explanation of which, we refer to the article CHEMISTRY, Vol. I. p. 226. of this *Supplement*.

12 Ductility and brittleness. VIII. With respect to DUCTILITY and BRITTLENESS, minerals are either *malleable*; *sectile*, capable of being cut without breaking, but not malleable; *flexile*, capable of being bent, and when bent retaining their shape; or *elastic*, capable of being bent, but recovering their former shape. Minerals destitute of these properties are *brittle*. Brittle minerals, with respect to the ease with which they may be broken, are either *very tough*, *tough*, *fragile*, or *very fragile*.

13 Fracture. IX. By FRACTURE is meant the fresh surface which a mineral displays when broken. It is either *flat*, without any general elevation or depression; or *conchoidal*, having wide extended roundish hollows and gentle risings. When these are not *very* evident, the fracture is called *flat* conchoidal; when they are small, it is called *small* conchoidal; and when of great extent, *great* conchoidal.

The fracture may also be *even*, free from all asperities; *uneven*, having many small, sharp, abrupt, irregular elevations and inequalities; and from the size of these, this fracture is denominated *coarse*, *small*, or *fine*; *splintery*, having small, thin, half detached, sharp edged splinters, according to the size of which this fracture is denominated *coarse* or *fine*; or *rugged*, having many very minute sharp hooks, more sensible to the hand than the eye.

14 Texture. X. By TEXTURE is meant the internal structure or disposition of the matter of which a mineral is composed, which may be discovered by breaking it. The texture is either *compact*, without any distinguishable parts, or the appearance of being composed of smaller parts; *earthy*, composed of very minute *almost* imperceptible rough parts; *granular*, composed of small shapeless grains; *globuliform*, composed of small spherical bodies; *fibrous*, composed of fibres which may be *long*, *short*, *straight*, *crooked*, *parallel*, *divergent*, *stellated*, *fasciculated*, or *decussated*; *radiated*, consisting of long narrow flattish lamellæ; or *lamellar* or *foliated*, consisting of smooth continued plates covering each other; these plates may be either *straight*, *crooked*, or *undulating*.

XI. The STRUCTURE or COMPOUND TEXTURE is the manner in which the parts that form the texture are disposed. It is either *slaty*, in straight layers like slate; *testaceous*, in incurvated layers; *concentric*, in concentric layers; or *columnar*, in columns. 15 Structure.

The *texture* and *structure* may at first view appear the same; but in reality they are very different. Thus common slate has often the *slaty structure* and *earthy texture*. The texture of pitcoal is compact, but its structure is often slaty.

XII. By FRAGMENTS is meant the shape of the pieces into which a mineral breaks when struck with a hammer. They are either *cubic*; *rhomboidal*; *wedgeshaped*; *splintery*, thin, long, and pointed; *tabular*, thin, and broad, and sharp at the corners, as common slate; or *indeterminate*, without any particular resemblance to any other body. The *edges* of indeterminate fragments are either *very sharp*, *sharp*, *sharpish*, or *blunt*. 16 Fragments.

XIII. By the FEEL of minerals is meant the sensation which their surfaces communicate when handled. The feel of some minerals is *greasy*, of others, *dry*, &c. 17 Feel.

XIV. Some minerals when struck give a *clear* SOUND, as common slate; others a *dull* sound. 18 Sound.

The SMELL, TASTE, SPECIFIC GRAVITY, and MAGNETISM of minerals, require no explanation.

With respect to ELECTRICITY, some minerals become electric when *heated*, others when *rubbed*, others cannot be rendered electric. The electricity of some minerals is *positive* or *vitreous*, of others *negative* or *resinous*.

As for the CHEMICAL properties of minerals, they have been already explained in the article CHEMISTRY, which makes a part of this *Supplement*. And for the description of the blow-pipe, and the manner of using it, we refer the reader to a treatise on that subject prefixed to the article MINERALOGY in the *Encyclopædia*.

Chap. II. Of the Arrangement of Minerals.

MINERALS may be arranged two ways, according to their external characters, and according to their chemical composition. The first of these methods has been called an *artificial* classification; the second, a *natural* one. The first is indispensably necessary for the student of nature; the second is no less indispensable for the proficient who means to turn his knowledge to account. Without the first, it is impossible to discover the *names* of minerals; and without the second, we must remain ignorant of their use.

Almost every system of mineralogy hitherto published, at least since the appearance of Werner's *external characters*, has attempted to combine these two arrangements, and to obtain at one and the same time the advantages peculiar to each. But no attempt of this kind has hitherto succeeded. Whether this be owing to any thing impossible in the undertaking, or to the present

(c) These four degrees have been denoted by Kirwan by the figures 4, 3, 2, 1, and no lustre by 0. We have imitated him in the present article.

Artificial System.

present imperfect state of mineralogy, as is more probable, we do not take upon us to determine. But surely the want of success, which has hitherto attended all attempts to combine the two arrangements, ought to suggest the propriety of separating them. By adhering strictly to one language, the trouble of studying two different systems would be entirely prevented. They would throw mutual light upon each other; the artificial system would enable the student to discover the *names* of minerals; the natural would enable him to arrange them, and to study their properties and uses.

The happy arrangement of Cronstedt, together with the subsequent improvements of Bergman, Werner, Kirwan, Hauy, and other celebrated mineralogists, has brought the *natural* system of mineralogy to a considerable degree of perfection. But an *artificial* system is still a desideratum; for excepting Linnæus, whose success was precluded by the state of the science, no one has hitherto attempted it. Though we are very far from thinking ourselves sufficiently qualified for undertaking suck a task, we shall neverthelefs venture, in the next chapter, to sketch out the rudiments of an artificial system. The attempt, at least, will be laudable, even though we should fail.

Chap. III. Artificial System.

19 Artificial classes.

Minerals may be divided into six classes:

1. Minerals that cannot be fused by the blow-pipe *per se*.
2. Minerals fusible *per se* by the blow-pipe.
3. Minerals fusible by the blow-pipe *per se* when exposed to the blue flame, but not when exposed to the yellow flame.
4. Minerals fusible *per se* by the blow-pipe; and when in fusion, partly evaporating in a visible smoke.
5. Minerals which totally evaporate before the blow-pipe.
6. Minerals totally soluble in muriatic acid with effervescence, the solution colourless.

Under these heads we shall arrange the subjects of the mineral kingdom.

Class I. INFUSIBLE.

ORDER I. Specific gravity from 16 to 12.
Genus I. Colour whitish iron grey.
Species 1. Native platinum.

ORDER II. Sp. gr. 8.5844 to 7.006.
Genus I. Attracted by the magnet.
Sp. 1. Native iron.
Genus II. Not attracted by the magnet.
Sp. 1. Native copper.
Flexible and malleable. Colour usually red.
Sp. 2. Wolfram.
Brittle. Colour usually brown or black.

ORDER III. Sp. gr. from 6.4509 to 5.8.
Genus I. Forms a blue glass with microcosmic salt, which becomes colourless in the yellow, but recovers its colour in the blue flame.
Sp. 1. Tungstat of lime.
Genus II. Forms with microcosmic salt a permanently coloured bead.
Sp. 1. Sulphuret of cobalt.

ORDER IV. Sp. gr. from 4.8 to 4.5.
Genus I. Tinges borax dark green.
Sp. 1. Common magnetic iron stone.
Genus II. Tinges borax reddish brown.
Sp. 1. Grey ore of manganese.

ORDER V. Sp. gr. from 4.4165 to 3.092. Infusible with fixed alkalies.
Genus I. Hardness 20.
Sp. 1. Diamond.
Genus II. Hardness 15 to 17. Causes single refraction.
Sp. 2. Telesia.
Sp. 2. Corundum.
Genus III. Hardness 13. Single refraction.
Sp. 1. Ruby.
Crystallizes in octahedrons.
Genus IV. Hardness 12. Single refraction.
Sp. Chrysoberyl.
Genus V. Hardness 12. Causes double refraction. Becomes electric when heated.
Sp. 1. Topaz.
Genus VI. Hardness 10 to 16. Double refraction. Sp. gr. 4.2 to 4.165.
Sp. 1. Zircon.
Genus VII. Hardness 6 to 9. Feels greasy.
Sp. 1. Cyanite.
Genus VIII. Hardness 9 to 10. Feel not greasy. Double refraction. Sp. gr. 3.283 to 3.285.
Sp. 1. Chrysolite.
Genus IX. Hardness 12. Infusible with borax. Colour of large masses black, of thin pieces deep green.
Sp. 1. Cylanite.
(Phosphat of lime.)

ORDER VI. Sp. gr. from 2.9829 to 1.987. Infusible with fixed alkalies.
Genus I. Hardness 12.
Sp. 1. Emerald.
Genus II. Hardness 10.
Sp. 1. Jade.
Genus III. Hardness 6 to 7. Somewhat transparent.
Sp. 1. Phosphat of lime.
Before the blow-pipe becomes surrounded with a luminous green vapour.
Genus IV. Hardness 6. Opaque.
Sp. 1. Micarelle.
Genus V. Stains the fingers. Colour lead grey.
Sp. 1. Plumbago.
Spanish wax rubbed with plumbago does not become electric; or if it does, the electricity is negative. Streak lead grey even on earthen ware.

ORDER VII. Sp. gr. from 4.7385 to 4.569. Fusible with fixed alkalies.
Genus I. Stains the fingers. Colour lead grey.
Sp. 1. Molybdena.
Spanish wax rubbed with molybdena becomes positively electric. Streak on earthen ware yellowish green.

ORDER VIII. Sp. gr. from 4.1668 to 2.479. Fusible with fixed alkalies.
* Hardness from 10 to 12.

Genus

Artificial Syftem.

Genus I. Ufually white. Cryftals dodecahedrons. Double refraction. Fracture imperfectly conchoidal or fplintery. Brittle.

Sp. 1. Quartz.

Genus II. Ufually dark brown. Fracture perfectly conchoidal. Brittle. Eafily breaks into fplinters.

Sp. 1. Flint.

Genus III. Not brittle. Fracture even or imperfectly conchoidal.

Sp. 1. Chalcedony.

Sp. 2. Jafper.

Genus IV. Forms with potafs a violet glafs, with foda or borax a brown glafs, with microcofmic falt a honey yellow glafs. Colour green. Amorphous.

Sp. 1. Chryfoprafium.

Genus V. Tinges foda red. The colour difappears before the blue flame, and returns before the yellow flame.

Sp. 1. Oxide of manganefe and barytes.

Sp. 2. Black ore of manganefe.

Sp. 3. Carbonat of manganefe.

(*Brown ore of iron. Red ore of iron.*)

** Hardnefs 9 to 3.

Genus VI. Flexible and elaftic in every direction.

Sp. 1. Elaftic quartz.

Genus VII. Emits white flakes before the blowpipe.

Sp. 1. Blende.

Genus VIII. Becomes electric when heated.

Sp. 1. Calamine.

Genus IX. Tinges borax green. Blackens before the blow-pipe.

Sp. 1. Mountain blue.
Colour blue.

Sp. 2. Green carbonat of copper.
Colour green.

Genus X. Tinges borax green. Becomes attractable by the magnet by the action of the blowpipe.

Sp. 1. Brown iron ore.
Colour brown.

Sp. 2. Red iron ore.
Colour red.

Genus XI. Tinges borax fmutty yellow. Becomes brownifh black before the blow-pipe.

Sp. 1. Carbonat of iron.

Genus XII. Feels greafy.

Sp. 1. Steatites.

(*Black ore of Manganefe. Carbonat of manganefe. Mica.*)

ORDER IX. Sp. gr. from 2.39 to 1.7.

Genus I. Luftre glaffy.

Sp. 1. Opal.

Sp. 2. Hyalite.

Genus II. Luftre greafy.

Sp. 1. Pitchftone.

Genus III. Luftre waxy or pearly.

Sp. 1. Staurolite.

Class II. FUSIBLE.

ORDER I. Sp. gr. from 19 to 10.

Genus I. Colour yellow.

Sp. 1. Native gold.

Genus II. Colour white.

Sp. 1. Native filver.

Genus III. Colour yellowifh white.

Sp. 1. Alloy of filver and gold.

ORDER II. Sp. gr. from 7.786 to 4.5.

Genus I. Flexible and malleable.

Sp. 1. Sulphuret of filver.

** Brittle.

Genus II. Tinges borax white.

Sp. Tinftone.

Genus III. Tinges borax green.

Sp. 1. Sulphuret of copper.
Colour bluifh grey.

Sp. 2. Chromat of lead.
Colour aurora red.

Sp. 3. Purple copper ore.
Colour purple.

Genus IV. Tinges borax faint yellow. Becomes black when expofed to the vapour of fulphuret of ammonia.

Sp. 1. Galena.
Colour bluifh grey. Luftre metallic. Fragments cubic.

Sp. 2. Black lead ore.
Colour black. Luftre metallic.

Sp. 3. Lead ochre.
Colour yellow, grey, or red. Luftre 0.

Sp. 4. Carbonat of lead.
Colour white. Luftre waxy.

Sp. 5. Phofphat of lead.
Ufually green. Luftre waxy. After fufion by the blow-pipe cryftallizes on cooling.

Sp. 6. Molybdat of lead.
Colour yellow. Streak white. Luftre waxy.

ORDER III. Sp. gr. from 4.35 to 3.

* Hardnefs 14 to 9.

Genus I. Melts without frothing into a grey enamel.

Sp. 1. Garnet.
Colour red.

Genus II. Melts into a brownifh enamel.

Sp. 1. Shorl.
Colour black. Opaque.

Genus III. Froths and melts into a white enamel.

Sp. 1. Tourmaline.
Becomes electric by heat.

Genus IV. Froths and melts into a greenifh black enamel.

Sp. 1. Bafaltine.

Genus V. Froths and melts into a black enamel.

Sp. 1. Thallite.
Colour dark green.

Sp. 2. Thumerftone.
Colour clove brown.

** Hardnefs 5 to 8.

Genus VI. Melts into a tranfparent glafs.

Sp. 1. Fluat of lime.
Powder phofphorefces when thrown on a hot iron.

Genus VII. Melts into a black glafs.

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Sp. 1. Hornblende.

Genus VIII. Melts into a black bead with a sulphureous smell, and deposits a blue oxide on the charcoal.

Sp. 1. Sulphuret of tin.

Genus IX. Melts into a brown glass. Tinges borax violet.

Sp. 1 Asbestoid.
Colour green.

Genus X. Melts into a brown (?) glass. When fused with potass, and dissolved in water, the solution becomes of a fine orange yellow.

Sp. 1. Chromat of iron.

Genus XI. Before the blow-pipe yields a bead of copper.

Sp. 1. Red oxide of copper.
(Sulphuret of copper.)

ORDER IV. Sp. gr. from 2.945 to 2.437.

Genus I. Composed of scales.

Sp. 1. Talk.
Feels greasy. Spanish wax rubbed by it becomes positively electric.

Genus II. Composed of thin plates, easily separable from each other.

Sp. 1. Mica.
Plates flexible and elastic, may be torn but not broken. Spanish wax rubbed by it becomes negatively electric.

Sp. 2. Stilbite.
Plates somewhat flexible. Colour pearl white. Powder renders syrup of violets green. Froths and melts into an opaque white enamel.

Sp. 3. Lepidolite.
Colour violet. Powder white with a tint of red. Froths and melts into a white semitransparent enamel full of bubbles.

Genus III. Texture foliated.

Sp. 1. Felspar.
Fragments rhomboidal. Hardness 9 to 10.

Sp. 2. Leucite.
Always crystallized. White. Powder renders syrup of violets green. Hardness 8 to 10.

Sp. 3. Argentine felspar.
Always crystallized. Two faces dead white, two silvery white.

Sp. 4. Prehnite.
Colour green. Froths and melts into a brown enamel.

Genus IV. Texture fibrous. Fibres easily separated.

Sp. 1. Asbestus.
Feels somewhat greasy.

Genus V. Texture striated.

Sp. 1. Ædelite.
Absorbs water. Froths and melts into a frothy mass.

Genus VI. Texture earthy or compact.

Sp. 1. Lazulite.
Froths and melts into a yellowish black mass. If previously calcined, gelatinizes with acids.

Sp. 2. Borat of lime.
Tinges the flame greenish, froths and melts into a yellowish enamel garnished with small projecting points. If the blast be continued, these dart off in sparks.

ORDER V. Sp. gr. from 2.348 to 0.68.

Genus I. Hardness 10.

Sp. 1. Obsidian.
Colour blackish, in thin pieces green.

Genus II. Hardness 6 to 8.

Sp. 1. Zeolite.
Gelatinizes with acids. Becomes electric by heat.

Genus III. Hardness 3 to 4.

Sp. 1. Amianthus.
Feels greasy. Texture fibrous.

Sp. 2. Mountain cork.
Elastic like cork.

Class III. FUSIBLE by the BLUE FLAME, INFUSIBLE by the YELLOW.

Genus I. Sp. gr. from 4.43 to 4.4.

Sp. 1. Sulphat of barytes.

Genus II. Sp. gr. from 3.96 to 3.51.

Sp. 1. Sulphat of strontites.

Genus III. Sp. gr. from 2.311 to 2.167.

Sp. 1. Sulphat of lime.

Class IV. FUSIBLE, and partly EVAPORATING.

ORDER I. Sp. gr. from 10 to 5.

Genus I. Colour white or grey. Lustre metallic.

* Sp. gr. 9 to 10.

Sp. 1. Native amalgam.
Tinges gold white. Creaks when cut.

Sp. 2. Alloy of silver and antimony.
Powder greyish black.

** Sp. gr. from 6.467 to 5.309.

Sp. 3. Sulphuret of bismuth.
Melts when held to the flame of a candle.

Sp. 4. Dull grey cobalt ore.
Streak bluish grey. Hardness 10. When struck emits an arsenical smell. Lustre scarcely metallic.

Genus II. Colour red, at least of the streak.

Sp. 1. Red silver ore.
Burns with a blue flame.

Sp. 2. Hepatic mercurial ore.
Does not flame, but gives out mercury before the blow-pipe.

Genus III. Colour blue.

Sp. 1. Blue lead ore.
Burns with a blue flame and sulphureous smell, and leaves a button of lead.

Genus IV. Colour yellowish green.

Sp. 1. Phosphat and arseniat of lead combined.
When fused by the blow-pipe, crystallizes on cooling.

Genus V. Colour usually that of copper. Sp.

gr.

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gr. 6.6084 to 6.6481.

Sp. 1. Sulphuret of nickel.

Exhales before the blow-pipe an arsenical smoke.

ORDER II. Sp. gr. from 4.6 to 3.44.

GENUS I. Colour grey.

Sp. 1. Grey ore of antimony.

Burns with a blue flame, and leaves a white oxyd.

Sp. 2. Grey copper ore.

Crackles before the blow-pipe.

GENUS II. Colour yellow.

Sp. 1. Pyrites.

Burns with a blue flame and sulphureous smell, and leaves a brownish bead.

Sp. 2. Yellow copper ore.

Melts into a black mass.

CLASS V. EVAPORATING.

ORDER I. Sp. gr. 13.6.

GENUS I. Fluid.

Sp. 1. Native mercury.

ORDER II. Sp. gr. from 10 to 5.419.

GENUS I. Colour red.

Sp. 1. Native cinnibar.

GENUS II. Colour white or grey. Lustre metallic.

Sp. 1. Native bismuth.

Melts into a white bead, and then evaporates in a yellowish white smoke. Sp. gr. 9 to 9.5.

Sp. 2. Native antimony.

Melts and evaporates in a grey smoke. Sp. gr. 6.6 to 6.8.

Sp. 3. Native arsenic.

Evaporates without melting, and gives out a garlic smell.

ORDER III. Sp. gr. from 4.8 to 3.33.

GENUS I. Colour red.

Sp. 1. Red antimonial ore.

Melts with a sulphureous smell. Sp. gr. 4.7.

Sp. 2. Realgar.

Melts with a garlic smell. Sp. gr. 3.384

GENUS II. Colour yellow.

Sp. 1. Orpiment.

CLASS VI. SOLUBLE WITH EFFERVESCENCE IN MURIATIC ACID.

GENUS I. Sp. gr. from 4.338 to 4.3.

Sp. 1. Carbonat of barytes.

GENUS II. Sp. gr. from 3.66 to 3.4.

Sp. 1. Carbonat of strontites.

GENUS III. Sp. gr. from 2.8 to 1 or under.

Sp. 1. Carbonat of lime.

Natural System.

We have purposely avoided giving names to the classes, orders, and genera; because a more careful examination will doubtless suggest many improvements in the arrangement, and an artificial system ought to be brought to a great degree of perfection before its classes, orders, and genera be finally settled.

We have excluded from this arrangement all those bodies which in the following system are arranged under the class of combustibles; because there can scarcely be any difficulty in distinguishing them both from the other classes and from one another. For similar reasons we have excluded the class of salts.

CHAP. IV. NATURAL SYSTEM.

Avicenna, a writer of the 11th century, divided minerals into four classes; stones, salts, inflammable bodies, and metals (D). This division has been, in some measure, followed by all succeeding writers. Linnæus, indeed, the first of the moderns who published a system of mineralogy, being guided by the external characters alone, divided minerals into three classes, *petræ*, *mineræ*, *fossilia:* but Avicenna's classes appear among his orders. The same remark may be made with respect to the systems of Wallerius, Wolfterdorf, Cartheuser, and Justi, which appeared in succession after the first publication of Linnæus's *Systema Naturæ*, in 1736. At last in 1758, the system of Cronstedt appeared. He reinstated the classes of Avicenna in their place; and his system was adopted by Bergman, Kirwan, Werner, and the most celebrated mineralogists who have written since. We also shall adopt his classes, with a few slight exceptions; because we are not acquainted with any other division which is intitled to a preference.

20 Natural Classes.

We shall therefore divide this treatise into four classes. I. Stones. II. Salts. III. Combustibles. IV. Ores. The first class comprehends all the minerals which are composed chiefly or entirely of earths; the second, all the combination of acids and alkalies which occur in the mineral kingdom; the third, those minerals which are capable of combustion, and which consist chiefly of sulphur, carbon, and oil; the fourth, the mineral bodies which are composed chiefly of metals.

CLASS I. EARTHS AND STONES.

WE shall divide this class into three orders. The first order shall comprehend all chemical combinations of earths with each other; the second order, chemical combinations of earths with acids; and the third order, mechanical mixtures of earths or stones. All the minerals belonging to the first order exhibit the same homogeneous appearance to the eye as if they were simple bodies. We shall therefore, for want of a better name, call the first order *simple;* the second order we shall distinguish by the epithet of *saline;* and the third we shall call

(D) Corpora mineralia in quatuor species dividuntur, scilicet in lapides, et in liquifactiva, sulphurea, et sales. Et horum quædam sunt raræ substantiæ et debilis compositionis, et quædam fortis substantiæ, et quædam ductilia, et quædam non. *Avicenna de congelatione et conglutinatione lapidum*, Cap. 3. *Theatrum Chemicum* t. iv. p. 997.

Earths and Stones. call *aggregates*; becaufe moft of the minerals belonging to it confift of various *fimple ftones*, cemented, as it were, together.

Order I. SIMPLE STONES.

21 Cronftedt's genera. Cronstedt divided this order into nine genera, correfponding to nine earths; one of which he thought compofed the ftones arranged under each genus. The names of his genera, were *calcaræ*, *filicæ*, *granatinæ*, *argillaceæ*, *micacæ*, *fluores*, *afbeftinæ*, *zeolithicæ*, *magnefiæ*. All his earths were afterwards found to be compounds, except the firft, fecond, fourth, and ninth. Bergman,

22 Improved. therefore, in his Sciagraphia, firft publifhed in 1782, reduced the number of genera to five; which was the number of primitive earths known when he wrote. Since that period three new earths have been difcovered. Accordingly, in the lateft fyftems of mineralogy, the genera belonging to this order amount to eight. Each genus is named from an earth; and they are arranged in the neweft Wernerian fyftem, which we have feen, as follows:

1. Jargon genus.	5. Magnefian genus.
2. Siliceous genus.	6. Calcareous genus.
3. Glucina genus.	7. Barytic genus.
4. Argillaceous genus.	8. Strontian genus.

Mr Kirwan, in his very valuable fyftem of mineralogy, has adopted the fame genera. Under each genus, thofe ftones are placed, which are compofed chiefly of the earth which gives a name to the genus, or which at leaft are fuppofed to poffefs the characters which diftinguifh that earth.

23 Still deficient. A little confideration will be fufficient to difcover that there is no natural foundation for thefe genera. Moft ftones are compofed of two, three, or even four ingredients; and, in many cafes, the proportion of two or more of thefe is nearly equal. Now, under what genus foever fuch minerals are arranged, the earth which gives it a name muft form the fmalleft part of their compofition. Accordingly, it has not been fo much the chemical compofition, as the external character, which has guided the mineralogift in the diftribution of his fpecies. The genera cannot be faid properly to have any character at all, nor the fpecies to be connected by any thing elfe than an arbitrary title. This defect, which muft be apparent in the moft valuable fyftems of mineralogy, feems to have arifen chiefly from an attempt to combine together an artificial and natural fyftem. As we have feparated thefe two from each other, it becomes neceffary for us to attend more accurately to the natural diftribution of genera than has hitherto been done. We have accordingly ventured to form new genera for this order, and we have formed them according to the following rules.

24 New genera. The only fubftances which enter into the minerals belonging to this order, in fuch quantity as to deferve attention, are the following:

Alumina,	Glucina,
Silica,	Zirconia,
Magnefia,	Oxide of iron,
Lime,	Oxide of chromum,
Barytes,	Potafs,

All thofe minerals which are compofed of the *fame* ingredients we arrange under the *fame* genus. According to this plan, there muft be as many genera as there are varieties of combinations of the above fubftances exifting in nature. The varieties in the *proportion* of the ingredients conftitute fpecies. We have not impofed names upon our genera, but, in imitation of Bergman*, have denoted each by a fymbol. This fymbol is compofed of the firft letter of every fubftance which enters in any confiderable quantity into the compofition of the minerals arranged under the genus denoted by it. Thus, fuppofe the minerals of a genus to be compofed of *alumina*, *filica*, and *oxide of iron*, we denote the genus by the fymbol *afi*. The letters are arranged according to the proportion of the ingredients; that which enters in the greateft proportion being put firft, and the others in their order. Thus the genus *afi* is compofed of a confiderable proportion of alumina, of a fmaller proportion of filica, and contains leaft of all of iron. By this contrivance, the fymbol of a genus contains, within the compafs of a few letters, a pretty accurate defcription of its nature and character. Where the proportions of the ingredients vary in the fame genus fo much, that the letters which conftitute its fymbol change their place, we fubdivide the genus into parts; and whenever the minerals belonging to any genus become too numerous, advantage may be taken of thefe fubdivifions, and each of them may be formed into a feparate genus. At prefent this feems unneceffary (E).

* *Opufc* iv. 231.

The following is a view of the different genera belonging to this order, denoted each by its fymbol. Every genus is followed by the fpecies included under it; and the whole are in the order which we mean to follow in defcribing them:

I. A.
- Telefia,
- Corundum,
- Native alumina.

II. AMC.
- Ruby.

III. AIM.
- Ceylanite.

IV. S.
- Quartz,
- Elaftic quartz,
- Flint,
- Opal,
- Pitchftone,
- Chryfoprafium.

V. 1. AS.
- Topaz,
- Sommite,
- Shorlite.

2. SA.
- Rubellite,
- Hornflate,
- Hornftone,
- Chalcedony,
- Jafper.
- Tripoli.

VI. 1. ASI.
- Micarell,
- Shorl,
- Granatite,

2. SAI.
- Tourmaline,
- Argentine felfpar,
- Mica,
- Talc,
- Bafaltine,
- Hornblende,
- Obfidian,
- Petrilite,
- Felfite.

VII. SAP.
- Felfpar,
- Lepidolite,
- Leucite.

VIII. SAG.
- Emerald.

IX. SAB.
- Staurolite.

X. 1. ASL.
- Chryfoberyl.

2. SAL.
- Hyalite,
- Ædelite.

3. SAWL

(E) We need hardly remark, that the laft three genera of Werner belong to the fecond order of the firft clafs of this treatife.

Earths and Stones.

3. SAWL.
Zeolite,
Stilbite,
Analcime.
4. SLA.
Lazulite.
XI. SALI.
Garnet,
Thumerftone,
Prehnite,
Thallite.
XII. 1. AMS.
Cyanite.
2. MSA.
Serpentine.
XIII. MSAI.
Potftone,
Chlorite.
XIV. SLAM.
Siliceous fpar.
XV. SAMLI.
Argillite.
XVI. SM.
Kiffekill,
Steatites.
XVII. MSI.
Chryfolite,
Jade.
XVIII. SML.
Afbeftus,
Afbeftinite.
XIX. 1. SILM.
Pyroxen,
Afbeftoid.
2. SMIL.
Actinolite.
XX. SL.
Shiftofe hornftone.
XXI. ZS.
Zircon.

25 G. I. A. Telefia.

GENUS I. A.

SPECIES 1. Telefia (F).

Oriental ruby, fapphire, and *topaz* of mineralogifts.—*Rubis d'orient* of De Lifle.

Three ftones, diftinguifhed from each other by their colour, have long been held in high eftimation on account of their hardnefs and beauty. Thefe ftones were known among lapidaries by the names of *ruby*, *fapphire*, and *topaz*, and the epithet *oriental* was ufually added, to diftinguifh them from other three, known by the fame names and the fame colours, but very inferior in hardnefs and beauty. Mineralogifts were accuftomed to confider thefe ftones as three diftinct fpecies, till Romé de Lifle obferved that they agreed in the form of their cryftals, their hardnefs, and moft of their other properties. Thefe obfervations were fufficient to conftitute them one fpecies; and accordingly they were made one fpecies by Romé de Lifle himfelf, by Kirwan, and feveral other modern mineralogical writers. But this fpecies was deftitute of a proper name, till Mr Hauy, whofe labours, diftinguifhed equally by their ingenuity and accuracy, have contributed not a little to the progrefs of mineralogy, denominated it *telefia*, from the Greek word τελεσιος, which fignifies *perfect*.

The telefia is found in the Eaft Indies, efpecially in Pegu and the ifland of Ceylon; and it is moft commonly cryftallized. The cryftals are of no great fize: Their *primitive* form, according to Mr Hauy, is a regular fix-fided prifm, divifible in directions parallel both to its bafes and its fides; and confequently giving for the form of its primitive nucleus, or of its *integrant molecule*, an equilateral three-fided prifm *. The moft ufual variety is a dodecahedron, in which the telefia appears under the form of two very long flender fix-fided pyramids, joined bafe to bafe †. The fides of thefe pyramids are ifofceles triangles, having the angle at their vertex 22° 54′, and each of thofe at the bafe 78° 48′ (G). The inclination of a fide of one pyramid to a contiguous fide of the other pyramid is 139° 54′ ‡. In fome fpecimens the fummits of the pyramids are wanting, fo that the cryftal has the appearance of a fix fided prifm, fomewhat thicker in the middle than towards the extremities §. The three alternate angles at each extremity of this prifm are alfo fometimes wanting, and a fmall triangular face inftead of them, which renders the bafes of the fuppofed prifm nine-fided. The inclination of each of thefe fmall triangles to the bafe is 122° 18′ ¶. For figures of thefe cryftals we refer the reader to Romé de Lifle and Hauy ‖.

* Ann de Chim. xvii. 313.
† Plate XXXVI. fig. 1.
‡ Ibid and Romé de Lifle, ii. 315.
§ Fig. 2.
¶ Hauy, ibid.
‖ Ibid.

The texture of the telefia is foliated, and the joints are parallel to the bafe of the prifm *. Its luftre varies from 3 to 4 (H). Tranfparency ufually 3 or 4, fometimes only 2. It caufes only a fingle refraction. Specific gravity from 4. to 4.288. Hardnefs from 15 to 17. It is either colourlefs or red, yellow or blue. Thefe colours have induced lapidaries to divide the telefia into the three following varieties.

* Hauy.

Variety 1. Red telefia.
Oriental ruby.

Colour carmine red, fometimes verging towards violet. Sometimes various colours appear in the fame ftone, as red and white, red and blue, orange red. Hardnefs 17. Sp. gr. 4.288.

Variety 2. Yellow telefia.
Oriental topaz.

Colour golden yellow. Tranfp. 4. Hardnefs 15. Sp. gr. 4.0106.

Variety 3. Blue telefia.
Oriental fapphyr.

Colour Berlin blue, often fo very faint that the ftone appears almoft colourlefs. Tranfp. 3, 4, 2. Hardnefs 17. Sp. gr. 3.991 to 4.083 †. That variety is not probably the fame with the fapphyr of the ancients. Their fapphyr was diftinguifhed by gold-coloured fpots, none of which are to be feen in the fapphyr of the moderns ‡.

A fpecimen of this laft variety, analyfed by Mr Klaproth, was found to contain in 100 parts,

98.5 alumina,
1.0 oxyd of iron,
0.5 lime,

100.0 §

† Greville, Nicholfon's Jour. iii. 11.
‡ Hill's Theophraftus, περι των λιθων, p. 100.
§ Beiträge, i. 81.

The colouring matter of all thefe varieties is, according to Bergman's experiments, iron in different ftates of oxydation. He found that the topaz contained .06, the ruby .1, and the fapphyr .02 of that metal ‖. But when thefe experiments were made, the analyfis of ftones was not arrived at a fufficient degree of perfection to enfure accuracy. No conclufion, therefore, can be drawn from thefe experiments, even though we were certain that they were made upon the real varieties of telefia.

‖ Bergman, ii. 96.

(F) See *Kirwan's Mineralogy*, I. 250.—*Gmelin's Syftema Naturæ of Linnæus*, III. 170.—*Romé de Lifle's Cryftallographie*, II. 212.—*Bermanni Opufcula*, II. 72.

(G) In fome inftances, the angle at the vertex is 31°, thofe at the bafe 74° 30′, and the inclination of two triangles 122° 36′. See *Hauy, ibid.*

(H) When the *kind* of luftre is not fpecified, as in the prefent inftance, the *common* is always meant.

Earths and Stones.

26 Corundum.

SPECIES 2. Corundum (I).

Corundum of Gmelin—*Admantine fpar* of Klaproth and Kirwan *Corindon* of Hauy—*Corivindum* of Woodward.

This ftone, though it appears to have been known to Mr Woodward, may be faid to have been firft diftinguifhed from other minerals by Dr Black. In 1768, Mr Berry, a lapidary in Edinburgh, received a box of it from Dr Anderfon of Madras. Dr Black afcertained, that thefe fpecimens differed from all the ftones known to Europeans; and, in confequence of its hardnefs, it obtained the name of *adamantine fpar*. Notwithftanding this, it could fcarcely be faid to have been known to European mineralogifts till Mr Greville of London, who has done fo much to promote the fcience of mineralogy, obtained fpecimens of it, in 1784, from India, and diftributed them among the moft eminent chemifts, in order to be analyfed. Mr Greville alfo learned, that its Indian name was Corundum. It is found in Indoftan, not far from the river Cavery, which is fouth from Madras, in a rocky matrix, of confiderable hardnefs, partaking of the nature of the ftone itfelf *. It occurs alfo in China; and a fubftance, not unlike the matrix of corundum, has been found in Teree, one of the weftern iflands in Scotland †.

* *Garrow and Greville, Nicholfon's Jour.* ii. 540.
† *Greville, ibid.*

The corundum is ufually cryftallized. Its primitive form, difcovered by Mr Hauy ‡ and the Count de Bournon §, is a rhomboidal parallelopiped, whofe fides are equal rhombs, with angles of 86° and 94°, according to Bournon, or whofe diagnonals are to each other as $\surd 17$ to $\surd 15$, according to Hauy; which is very nearly the fame thing ¶. The moft common variety, for the primitive form has never yet been found, is the regular fix-fided prifm, the alternate angles of which are fometimes wanting ‖, and the triangular faces, which occupy their place, are inclined to the bafe at an angle of 122° 34′ *. Sometimes the corundum is cryftallized in the form of a fix-fided pyramid, the apex of which is generally wanting. For a defcription and figure of thefe, and all the other varieties of corundum hitherto obferved, we refer the reader to the differtation of the Count de Bournon on the fubject †.

‡ *Jour. de Min* N° xxviii. 262.
§ *Nicholfon's Jour.* ii. 541
¶ Fig. 3.
‖ Fig. 4
* *De Bournon.*
† See alfo *Hauy, Jour. de min.* N° xxviii. 262.

The texture of the corundum is foliated, and the natural joints are parallel to the faces of the primitive rhomboidal parallelopiped. Luftre, when in the direction of the laminæ, 3; when broken acrofs, 0. Opake, except when in very thin pieces. Hardnefs 15. Sp. gr. from 37.10 to 4.180 ‡. Colour grey, often with various fhades of blue and green.

‡ *Klaproth* See alfo *Mr Greville, Nicholfon's Jour.* iii. 11.

According to the analyfis of Klaproth, the corundum of India is compofed of

89.5	alumina,
5.5	filica,
1.25	oxide of iron,
96.25 §.	

§ *Beiträge,* i. 77.

A fpecimen from China of

84.0	alumina,
6.5	filica,
7.5	oxide of iron,
98.0 ‖.	

‖ *Ibid.* i. 73.

Simple Stones.

Notwithftanding the quantity of filica and of iron which thefe analyfes exhibit in the corundum, we have been induced to include it in the prefent genus on account of the ftrong refemblance between it and the third variety of telefia. The ftriking refemblance between the cryftals of telefia and corundum will appear evident, even from the fuperficial defcription which we have given; and the obfervations of De Bournon ¶ render this refemblance ftill more ftriking. It is not improbable, therefore, as Mr Greville and the Count de Bournon have fuggefted, that corundum may be only a variety of telefia, and that the feeming difference in their ingredients is owing to the impurity of thofe fpecimens of corundum which have hitherto been brought to Europe. Let not the difference which has been found in the primitive form of thefe ftones be confidered as an infuperable objection, till the fubject has been again examined with this precife object in view; for nothing is eafier than to commit an overfight in fuch difficult examinations.

¶ *Nicholfon's Jour.* iii. 9.

27 Native alumina.

SPECIES 3. Native alumina (K).

This fubftance has been found at Halles in Saxony in compact kidney-form maffes. Its confiftence is earthy. Luftre 0. Opaque. Hardnefs 4. Brittle. Sp. gr. moderate. Feels foft, but meagre. Adheres very flightly to the tongue. Stains very flightly. Colour pure white. Does not readily diffufe itfelf in water.

It confifts of pure alumina, mixed with a fmall quantity of carbonat of lime, and fometimes of fulphat of lime *.

* *Schreber.*

28 G. II. AMC. Ruby.

GENUS II. AMC.

SPECIES I. Ruby (L).

Spinel and *balafs Ruby* of Kirwan—*Ruby* of Hauy—*Rubis fpinelle octoedre* of De Lifle—*Spinellus* of Gmelin.

This ftone, which comes from the ifland of Ceylon, is ufually cryftallized. The primitive form of its cryftals is a regular octohedron, compofed of two four-fided pyramids applied bafe to bafe, each of the fides of which is an equilateral triangle † (M). In fome cafes two oppofite fides of the pyramids are broader than the other two; and fometimes the edges of the octohedron are wanting, and narrow faces in their place. For figures and defcriptions of thefe, and other varieties of thefe cryftals, we refer the reader to *Romé de Lifle* and the *Abbé Eftner* ‡.

† Fig. 5.

The texture of the ruby is foliated. Its luftre is 3. Tranfp. 3.4. It caufes a fingle refraction. Hardnefs 13. Sp. gr. 3.570 § to 3.625 ¶. Colour red; if deep, the ruby is ufually called *balafs*; if pale rofy, *fpinell*. The

‡ *Cryftal.* ii. 226. *Eftner's Miner.* 73.
§ *Klaproth.*
¶ *Hatchette* and *Greville.*

(I) See *Kirwan's Mineralogy*, I.—*Klaproth in Beob. der Berlin*, VIII. 295. and *Beiträge*, I. 47.—*Mr Greville* and the *Count de Bournon* in the *Philofophical Tranfactions* 1798, p. 403. and in *Nicholfon's Journal*, II. 540. and III. 5.—*Mr Hauy Jour. de Phyf.* XXX. 193. and *Jour. de Min.* N° XXVIII. 262.

(K) See *Kirwan's Mineralogy*, I. 175, and *Schreber.* 15. *Stück*, p. 209.

(L) See *Kirwan's Min.* I. 253.—*Romé de Lifle*, II. 224.—*Klaproth Beob. der Berlin*, III. 336. and *Beiträge*, II. 1.—*Vauquelin Ann. de Chim.* XXVII. 3. and XXXI. 141.

(M) We fhall afterwards diftinguifh this octohedron either by the epithet *regular* or *aluminiform*, becaufe it is the well-known form of cryftals of alum.

Earths and Stones.

The ruby, according to the analyſis of Vauquelin, is compoſed of

86.00	alumina,
8.50	magneſia,
5.25	chromic acid.
99.75 *	

* Ann. de Chim. xxvii. 15.

The ancients ſeem to have claſſed this ſtone among their hyacinths †.

† Plinii, l. 37. c. 9.

29

Genus III. aim.

G. III. aim. Ceylanite.

species 1. Ceylanite.

The mineral denominated *ceylanite*, from the iſland of Ceylon, from which it was brought into Europe, had been obſerved by Romé de Liſle ‡; but was firſt deſcribed by La Metherie in the Journal de Phyſique for January 1793.

‡ Cryſtallog. iii. 180. Note 21.

It is moſt commonly found in rounded maſſes; but ſometimes alſo cryſtallized. The primitive form of its cryſtals is a regular octahedron: it commonly occurs under this form, but more commonly the edges of the octahedron are wanting, and ſmall faces in their place §.

§ Hauy, Jour. de Min. N° xxxviii. 264.

The fracture of the ceylanite is conchoidal ||. Its internal luſtre is glaſſy. Nearly opaque, except when in very thin pieces. Hardneſs 12. Sp. gr. from 3.7647 * to 3.793 †. Colour of the maſs, black; of very thin pieces, deep green. Powder, greeniſh grey. According to the analyſis of Deſcotils, the ceylanite is compoſed of

|| Ibid. 263.
* Hauy.
† Deſcotils.

68	alumina,
16	oxide of iron,
12	magneſia,
2	ſilica.
98 ‡	

‡ Ann. de Chim. xxiii. 113.

30

Genus IV. s.

G. IV. s. Quartz.

species 1. Quartz §.

This ſtone, which is very common in moſt mountainous countries, is ſometimes cryſtallized, and ſometimes amorphous. The primitive form of its cryſtals, according to Mr Hauy, is a rhomboidal parallelopiped; the angles of whoſe rhombs are 93° 22′, and 86° 38′; ſo that it does not differ much from a cube ||. The moſt common variety is a dodecahedron *, compoſed of two ſix-ſided pyramids, applied baſe to baſe, whoſe ſides are iſoſceles triangles, having the angle at the vertex 40°, and each of the angles at the baſe 70°; the inclination of a ſide of one pyramid to the contiguous ſide of the other pyramid is 104°. There is often a ſix-ſided priſm interpoſed between the two pyramids, the ſides of which always correſpond with thoſe of the pyramids †. For a deſcription and figure of the other varieties of quartz cryſtals, and for a demonſtration of the law which they have followed in cryſtallizing, we refer the reader to *Romé de Liſle* ‡ and *Mr Hauy* §.

§ Kirwan's Min. i. 241.
|| Jour. de Min. N° xxviii. 255.
* Fig. 6.
† Fig. 7.
‡ Cryſtal. ii. 71.
§ Mem. Par. 1786, p. 78. See alſo Lametherie, Jour. de Phyſ. xiii. 470.

The texture of quartz is more or leſs foliated. Fracture, conchoidal or ſplintery. Its luſtre varies from 3 to 1, and its tranſparency from 4 to 1; and in ſome caſes it is opaque. It cauſes a double refraction. Hardneſs, from 10 to 11. Sp. gr. from 2.64 to 2.67, and in one variety 2.691. Its colour is exceedingly various; a circumſtance which has induced mineralogiſts to divide it into numerous varieties. Of theſe the following are the chief:

Simple Stones.

1. Pure colourleſs, perfectly tranſparent cryſtallized quartz, having much the appearance of artificial cryſtal: known by the name of *rock cryſtal*.

2. Quartz leſs tranſparent, and with a ſplintery fracture, has uſually been diſtinguiſhed by the name of *quartz*, and ſeparated from rock cryſtal. As there is no occaſion for this ſeparation, we have, in imitation of Mr Hauy, choſen the word quartz for the *ſpecific name*, comprehending under it all the varieties.

3. Blood red quartz; formerly called *compoſtella hyacinth*, and by Hauy *quartz hematoide*. It owes its colour to oxide of iron. The mineral known to mineralogiſts by the name of *ſinople*, and conſidered by them as a variety of *jaſper*, has been diſcovered by Dolomieu to be merely this variety of quartz in an amorphous ſtate *.

* Jour. de Min. N° xxviii. 255.

4. Yellow quartz; called falſe topaz.

5. Roſy red quartz; called Bohemian ruby.

For a fuller enumeration of theſe varieties, we refer the reader to *Smeiſſer's Mineralogy* †, *Kirwan's Mineralogy* ‡, and Gmelin's edition of the *Syſtema Naturæ* of Linnæus §. This laſt writer, however, has arranged ſeveral minerals under quartz which do not belong to it.

† i. 89.
‡ i. 244.
§ iii. 194.

Pure quartz is compoſed entirely of ſilica; but ſome of the varieties of this ſpecies are contaminated with metallic oxides, and with a ſmall quantity of other earths.

species 2. Elaſtic Quartz (n).

31 Elaſtic quartz.

This ſingular ſtone is moderately elaſtic, and flexible in every direction. Texture, earthy. Luſtre 0 or 1. Hardneſs, 9. Brittle. Sp. gr. 2.624. Colour, greyiſh white. Phoſphoreſces when ſcraped with a knife in the dark. The ſpecimen analyſed by Mr Klaproth contained

96.5	ſilica,
2.5	alumina,
5	oxide of iron.
99.5 ||	

|| Beiträge, ii. 116.

species 3. Flint (o).

32 Flint.

Pyromachus—Pierre a fuſil—Silex of Hauy.

This ſtone, which has become ſo neceſſary in modern war, is found in pieces of different ſizes, and uſually of a figure more or leſs globular, commonly among chalk, and often arranged in ſome kind of order. In Saxony it is ſaid to have been found cryſtallized in hexahedrons, compoſed of two low three-ſided pyramids applied baſe to baſe *.

* Gmelin's Syſtema Naturæ, iii. 318.

Its texture is compact. Its fracture, ſmooth conchoidal. Luſtre, external, 0, the ſtones being always covered by a white cruſt; internal, 1, inclining to greaſy. Tranſp. 2; when very thin, 3. Hardneſs, 10 or 11. Sp. gr. from 2.58 to 2.63. Colour varies from honey yellow to browniſh black. Very brittle, and ſplits into ſplinters in every direction. Two pieces of flint rubbed ſmartly together phoſphoreſce, and emit a peculiar odour. When heated it decrepitates, and becomes white and opaque. When expoſed long to the air

(n) *Kirwan's Min.* I. 316.—*Gerhard, Mem. Berlin*, 1783, 107.—*Klaproth's Beiträge, 2 Band.* 113. See alſo *Jour. de Phyſ.* XLI. 91.

(o) *Kirwan's Min.* I. 301.—*Dolomieu, Jour. de Min.* N° XXXIII. 693. and *Salivet, ibid.* 713. Theſe laſt gentlemen give the only accurate account of the method of making gun flints.

Earths and Stones.

air it often becomes covered with a white cruſt. A ſpecimen of flint, analyſed by Klaproth, contained

98.00	ſilica,
.50	lime,
.25	alumina,
0.25	oxide of iron,
1.00	water.
100.00 *	

Another ſpecimen, analyſed by Dolomieu, was compoſed of

97	ſilica,
1	alumina and oxide of iron,
2	water.
100 †	

The white cruſt with which flint is enveloped, conſiſts of the ſame ingredients, and alſo a little carbonat of lime. Dolomieu diſcovered that water is eſſential to flint; for when it is ſeparated by heat the ſtone loſes its properties ‡.

The manufacture of gun flints is chiefly confined to two or three departments in France. The operation is exceedingly ſimple: a good workman will make 1000 flints in a day. The whole art conſiſts in ſtriking the ſtone repeatedly with a kind of mallet, and bringing off at each ſtroke a ſplinter, ſharp at one end and thicker at the other. Theſe ſplinters are afterwards ſhaped at pleaſure, by laying the line at which it is wiſhed they ſhould break, upon a ſharp iron inſtrument, and then giving it repeatedly ſmall blows with a mallet. During the whole operation the workman holds the ſtone in his hand, or merely ſupports it on his knee §.

* Beiträge, i. 46.

† Jour. de Min. No xxxiii. 702.

‡ Ibid.

§ Ibid.

33 Opal.

SPECIES 4. Opal (P).

This ſtone is found in many parts of Europe. It is uſually amorphous. Its fracture is conchoidal, commonly ſomewhat tranſparent. Hardneſs from 6 to 10. Sp. gr. from 1.7 to 2.66. The lowneſs of its ſpecific gravity, in ſome caſes, is to be aſcribed to accidental cavities which the ſtone contains. Theſe are ſometimes filled with drops of water. Some ſpecimens of opal have the property of emitting various coloured rays, with a particular effulgency, when placed between the eye and the light. The opals which poſſeſs this property, are diſtinguiſhed by lapidaries by the epithet *oriental;* and often by mineralogiſts by the epithet *nobilis*. This property rendered the ſtone much eſteemed by the ancients.

Variety 1. Opal edler—*Opalus nobilis*.

Luſtre glaſſy, 3. Tranſp. 3 to 2. Hardneſs, 6 to 8. Colour, uſually light bluiſh white, ſometimes yellow or green. When heated it becomes opaque, and ſometimes is decompoſed by the action of the atmoſphere. Hence it ſeems to follow, that water enters eſſentially into its compoſition. A ſpecimen of this variety, analyſed by Klaproth, contained

90	ſilica,
10	water.
100 *	

* Beiträge, ii. 153.

Variety 2. Semi-opal.

Fracture, imperfectly conchoidal. Luſtre, glaſſy, 2. Tranſp. 2 to 3. Hardneſs, 7 to 9. Its colours are very various, greys, yellows, reds, browns, greens of different kinds.

Simple Stones.

Specimens of this variety ſometimes occur with rifts: theſe readily imbibe water, and therefore adhere to the tongue. Theſe ſpecimens ſometimes become tranſparent when ſoaked in water, by imbibing that fluid. They are then called *hydrophanes*.

Variety 3. Cat's eye *.

This variety comes from Ceylon, and is ſeldom ſeen by European mineralogiſts till it has been poliſhed by the lapidary. Mr Klaproth has deſcribed a ſpecimen which he received in its natural ſtate from Mr Greville of London. Its figure was nearly ſquare, with ſharp edges, a rough ſurface, and a good deal of brilliancy.

* Kirwan's Min. i. 301. Klaproth, Beiträge, i. 90.

Its texture is imperfectly foliated. Luſtre greaſy, 2. Tranſp. 3 to 2. Hardneſs 10. Sp. gr. 2.56 to 2.66. Colour, grey; with a tinge of green, yellow, or white: or brown, with a tinge of yellow or red. In certain poſitions it reflects a ſplendid white, as does the eye of a cat; hence the name of this ſtone.

Two ſpecimens, analyſed by Klaproth, the firſt from Ceylon, the other from Malabar, were compoſed of

95.00	94.50	ſilica,
1.75	2.00	alumina,
1.50	1.50	lime,
0.25	0.25	oxide of iron.
98.5 †	98.25 ‡	

† Beiträge, i. 94.

‡ Ibid. p. 96.

SPECIES 5. Pitchſtone §.

Menelites.

34 Pitchſtone.

This ſtone, which occurs in different parts of Germany, France, and other countries, has obtained its name from ſome reſemblance which it has been ſuppoſed to have to pitch. It is moſt uſually in amorphous pieces of different ſizes; and it has been found alſo cryſtallized in ſix-ſided priſms, terminated by three-ſided pyramids.

§ Kir. Min. i. 292.—Daubanton, Mem. Par. 1787, p. 86.

Its texture is conchoidal and uneven, and ſometimes approaches the ſplintery. Luſtre greaſy, from 3 to 1. Tranſp. 2 to 1, ſometimes 0. Hardneſs 8 to 10. Exceedingly brittle; it yields even to the nail of the finger. Sp. gr. 2.049 to 2.39. Its colours are numerous, greyiſh black, bluiſh grey, green, red, yellow of different ſhades. Sometimes ſeveral of theſe colours appear together in the ſame ſtone. A ſpecimen of pitchſtone from Meſnil-montant near Paris ‖, analyſed by Mr Klaproth, contained

‖ See Jour. de Phyſ. xxxi. 219.

85.5	ſilica,
11.0	air and water,
1.0	alumina,
.5	iron,
.5	lime and magneſia.
98.5 ¶	

¶ Beiträge, ii. 169.

SPECIES 6. Chryſopraſium (Q).

35 Chryſopraſium.

This mineral, which is found in different parts of Germany, particularly near Koſemütz in Sileſia, is always amorphous. Its fracture is either even or inclining to the ſplintery. Scarcely any luſtre. Tranſp. 2 to 3. Hardneſs 10 to 12. Sp. gr. 2.479. Colour, green. In a heat of 130° Wedgewood it whitens and becomes opaque.

A

(P) *Kirwan's Min.* I. 289.—*Hauy, Jour. d'Hiſt. Nat.* II. 9.—*Delius, Nouv. Jour. de Phyſ.* I. 45.

(Q) *Kirwan's Min.* I.—*Lehmann, Mem. Berlin,* 1755, p. 202.—*Klaproth Beitrage,* II. 127.

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A specimen of this stone, analysed by Mr Klaproth, contained 96.16 silica,
1.00 oxide of nickel,
0.83 lime,
0.08 alumina,
0.08 oxide of iron.
98.15 ‡

‡ Beiträge, ii. 133.

36 G. V. I. AS. Topaz.

GENUS V. I. AS.

SPECIES I. Topaz (R).

Occidental ruby, topaz, and *sapphyr.*

The name *topaz* has been restricted by Mr Hauy to the stones called by mineralogists occidental ruby, topaz, and sapphyr; which, agreeing in their crystallization and most of their properties, were arranged under one species by Mr Romé de Lisle. The word *topaz*, derived from an island in the Red Sea (S), where the ancients used to find topazes, was applied by them to a mineral very different from ours. One variety of our topaz they denominated *chrysolite.*

The topaz is found in Saxony, Bohemia, Siberia, and Brazil, mixed with other minerals in granite rocks.

It is commonly crystallized. The primitive form of its crystals is a prism whose sides are rectangles, and bases rhombs, having their greatest angles 124° 22′, and the integral molecule has the same form †; and the height of the prism is to a side of the rhomboidal bases as 3 to 2 ‡. The different varieties of topaz crystals hitherto observed, amount to 6. Five of these are eight-sided prisms, terminated by four sided pyramids, or wedge shaped summits, or by irregular figures of 7, 13, or 15 sides §; the last variety is a twelve-sided prism, terminated by six-sided pyramids wanting the apex. For an accurate description and figure of these varieties we refer the reader to Mr Hauy ||.

† Hauy, Jour. de Min. N° xxviii. 287.
‡ Fig. 8.
§ Fig. 9.
|| Jour. de Min. ibid.

The texture of the topaz is foliated. Its lustre is from 2 to 4. Transp. from 2 to 4. It causes a double refraction. Hardness 12 to 14. Sp. gr. from 3.5311 to 3.564. The Siberian and Brazil topazes, when heated, become positively electrified on one side, and negatively on the other ¶. It is infusible by the blow-pipe. The yellow topaz of Brazil becomes red when exposed to a strong heat in a crucible; that of Saxony becomes white by the same process. This shews us that the colouring matter of these two stones is different.

¶ Hauy, ibid.

The colour of the topaz is various, which has induced mineralogists to divide it into the following varieties:

1. Red topaz, of a red colour inclining to yellow; called *Brazilian* or *occidental ruby.*

2. Yellow topaz, of a golden yellow colour, and sometimes also nearly white; called *occidental* or *Brazil topaz.* The powder of this and the following variety causes syrup of violets to assume a green colour *.

3. *Saxon topaz.* It is of a pale wine yellow colour, and sometimes greyish white.

* Vauquelin, Jour. de Min. N° xxix. 165.

4. *Aigue marine.* It is of a bluish or pale green colour.

Simple Stones.

5. *Occidental sapphyr.* It is of a blue colour; and sometimes white.

A specimen of white Saxon topaz, analysed by Vauquelin, contained 68 alumina,
31 silica.
99 *.

* Jour. de Min. N° xxiv. 3.

SPECIES 2. Sommite.

37 Sommite.

This stone was called sommite by La Metherie, from the mountain Somma, where it was first found. It is usually mixed with volcanic productions. It crystallizes in six-sided prisms, sometimes terminated by pyramids. Colour white. Somewhat transparent. Sp. gr. 3.2741. Infusible by the blow-pipe. According to the analysis of Vauquelin, it is composed of

49 alumina,
46 silica,
2 lime,
1 oxide of iron.
98 †

† Ibid. N° xxviii. 279.

SPECIES 3. Shorlite ‡.

38

This stone, which received its name from Mr Klaproth, is generally found, in irregular oblong masses or columns, inserted in granite. Its texture is foliated. Fracture uneven. Lustre 2. Transparency 2 to 1. Hardness 9 to 10. Sp. gr. 3.53. Colour greenish white, or sulphur yellow. Not altered by heat. According to the analysis of Klaproth, it is composed of

‡ Kirwan's Min. i. 286.

50 alumina,
50 silica.
100

GENUS V. 2. SA.

39 G. V. 2. SA. Rubellite.

SPECIES 4. Rubellite (T).

Red shorl of Siberia.

This stone is found in Siberia mixed with white quartz. It is crystallized in small needles, which are grouped together and traverse the quartz in various directions. Texture fibrous. Fracture even, inclining to the conchoidal. Transparency 2; at the edges 3. Hardness 10. Brittle. Sp. gr. 3.1. Colour crimson, blood or peach red. By exposure to a red heat it becomes snow white; but loses none of its weight. It tinges soda blue, but does not melt with it.

According to the analysis of Mr Bindheim, it is composed of 57 silica,
35 alumina,
5 oxides of iron and manganese.
97

SPECIES 5. Hornslate (U).

40 Hornslate.

Shistose porphyry.

This stone, which occurs in mountains, is generally amorphous; but sometimes also in columns. Structure

(R) *Kirwan's Min.* I. 254.—*Pott. Mem. Berlin,* 1747, p. 46.—*Margraf, ibid.* 1776, p. 73. *and* 160.—*Henkel. Act. Acad. Nat. Cur.* IV. 316.

(S) It got its name from τοπαζα, *to seek*; because the island was often surrounded with fog, and therefore difficult to find. See *Plinii lb.* 37. c. 8.

(T) *Kirwan's Min.* I. 288. *Bindheim, Crell's Annals,* 1792, p. 320.

(U) *Kirwan's Min.* I. 307.—*Wiegleb, Crell's Annals,* 1787. 1 *Band.* 302.—See also *Reuss. Semml. Natur. Hist. Aufsäze,* p. 207.

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ture ſlaty. Texture foliated. Fracture uneven and ſplintery; ſometimes approaching the conchoidal. Luſtre 0. Tranſparency 1 or 0. Hardneſs about 10. Sp. gr. from 2.512 to 2.7. Colour different ſhades of *grey*, from *aſh* to *bluiſh* or *olive green*. Melts at 145° Wedgewood into an enamel. A ſpecimen, analyſed by Wedgewood, contained

73.0	ſilica,
23.9	alumina,
3.5	iron.
100.4	

41 Hornſtone.

SPECIES 6. Hornſtone (x).

Petroſilex—Chert.

This ſtone, which makes a part of many mountains, is uſually amorphous; but, as Mr Kirwan informs us, it has been found cryſtallized by Mr Beyer on Schneeberg. Its cryſtals are ſix-ſided priſms, ſometimes terminated by pyramids: hexahedrons, conſiſting of two three-ſided pyramids applied baſe to baſe; and cubes, or ſix-ſided plates *. Its texture is foliated. Fracture ſplintery, and ſometimes conchoidal. Luſtre 0. Tranſparency 1 to 2. The cryſtals are ſometimes opaque. Hardneſs 7 to 9. Sp. gr. 2.532 to 2.653. Colour uſually dark blue: but hornſtone occurs alſo of the following colours; grey, red, blue, green, and brown of different ſhades †.

* *Kirwan*, i. 303.

† *Schmeiſſer's Min.* i. 103.

According to Kirwan, it is compoſed of

72	ſilica,
22	alumina,
6	carbonat of lime.
100 ‡	

‡ *Ibid.* p. 305.

42 Chalcedony.

SPECIES 7. Chalcedony.

This ſtone is found abundantly in many countries, particularly in Iceland and the Faro iſlands. It is moſt commonly amorphous, ſtalactitical, or in rounded maſſes; but it occurs alſo cryſtallized in ſix-ſided priſms, terminated by pyramids, or more commonly in four or ſix ſided pyramids, whoſe ſides are convex. Surface rough. Fracture more or leſs conchoidal. Luſtre 1. Somewhat tranſparent. Hardneſs 10 to 11. Sp. gr. 2.56 to 2.665. Not brittle.

According to Bergman, the chalcedony of Foroe is compoſed of

84	ſilica,
16	alumina, mixed with iron.
100	

Variety 1. Common chalcedony.

Fracture even, inclining to conchoidal. Tranſparency 2 to 3; ſometimes 1. Its colours are various; it is moſt commonly greyiſh, with a tint of yellow, green, blue, or pearl; often alſo white, green, red, yellow, brown, black, or dotted with red. When ſtriped white and black, or brown, alternately, it is called *onyx*; when ſtriped white and grey, it is called *chalcedonix*. Black or brown chalcedony, when held between the eye and a ſtrong light, appears dark red.

Variety 2. Cornelian.

Fracture conchoidal. Tranſparency 3 to 1; often cloudy. Its colours are various ſhapes of red, brown, and yellow. Several colours often appear in the ſame maſs. To this variety belong many of the ſtones known by the name of *Scotch pebbles*.

Simple Stones.

SPECIES 8. Jaſper (y).

This ſtone is an ingredient in the compoſition of many mountains. It occurs uſually in large amorphous maſſes, and ſometimes alſo cryſtallized in ſix-ſided irregular priſms. Its fracture is conchoidal. Luſtre from 2 to 0, Either opaque, or its tranſparency is 1. Hardneſs 9 to 10. Sp. gr. from 2.5 to 2.82. Its colours are various. When heated, it does not decrepitate. It ſeems to be compoſed of ſilica and alumina, and often alſo contains iron. 43 Jaſper.

Variety 1. Common jaſper.

Sp. gr. from 2.58 to 2.7. Its colours are different ſhades of white, yellow, red, brown, and green; often variegated, ſpotted, or veined, with ſeveral colours.

Variety 2. Egyptian pebble.

This variety is found chiefly in Egypt. It uſually has a ſpheroidal or flat rounded figure, and is enveloped in a coarſe rough cruſt. It is opaque. Hardneſs 10. Sp. gr. 2 564. It is chiefly diſtinguiſhed by the variety of colours, which always exiſt in the ſame ſpecimen, either in concentric ſtripes or layers, or in dots or dentritical figures. Theſe colours are, different browns and yellows, milk white, and iſabella green; black alſo has been obſerved in dots.

Variety 3. Striped jaſper.

This variety is alſo diſtinguiſhed by concentric ſtripes or layers of different colours: theſe colours are, yellow, browniſh red, and green. It is diſtinguiſhed from the laſt variety by its occurring in large amorphous maſſes, and by its fracture, which is nearly even.

SPECIES 9. Tripoli.

This mineral is found ſometimes in an earthy form, but more generally indurated. Its texture is earthy. Its fracture often ſomewhat conchoidal Luſtre 0. Generally opaque. Hardneſs 4 to 7. Sp. gr. 2.080 to 2.529. Abſorbs water. Feel, harſh dry. Hardly adheres to the tongue. Takes no poliſh from the nail. Does not ſtain the fingers. Colour generally pale yellowiſh grey, alſo different kinds of yellow, brown, and white. 44 Tripoli.

It contains, according to Haaſſe, 90 parts of ſilica, 7 alumina, and 3 of iron. A mineral belonging to this ſpecies was analyſed by Klaproth, and found to contain

66.5	ſilica,
7.0	alumina,
2.5	oxide of iron,
1.5	magneſia,
1.25	lime,
19.	air and water.
97.75	

GENUS VI. I. ASI. 45 G. VI. I. ASI. Micarell.

SPECIES 1. Micarell *.

This name has been given by Mr Kirwan to a ſtone which former mineralogiſts conſidered as a variety of mica. It is found in granite. Its texture is foliated, and

* *Kirwan's Min.* i. 212.

(x) *Kirwan's Min.* I. 303.—*Baumer, Jour. de Phyſ.* II. 154. and *Monnet, ibid.* 331.—*Wiegleb, Crell's Annals*, 1788, p. 45. and 135.

(y) *Kirw. Min.* I. 309.—*Borral Hiſt. Natur. de Corſe.*—*Henkel Act. Acad. Nat. Curios.* V. 339.

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and it may be split into thin plates. Lustre metallic, 3. Opaque. Hardness 6. Sp. gr. 2.980. Colour brownish black. At 153° Wedgewood, it melts into a black compact glass, the surface of which is reddish *.

* Kirw. ibid.

A specimen analysed by Klaproth contained

63.00 alumina,
29.50 silica,
6.75 iron.
———
99.25

46 Shorl. † Ibid. i. 265.

SPECIES 2. Shorl †.

No word has been used by mineralogists with less limitation than *shorl*. It was first introduced into mineralogy by Cronstedt, to denote any stone of a columnar form, considerable hardness, and a specific gravity from 3 to 3.4. This description applied to a very great number of stones. And succeeding mineralogists, though they made the word more definite in its signification, left it still so general, that under the designation of *shorl* almost 20 distinct species of minerals were included.

Mr Werner first defined the word *shorl* precisely, and restricted it to one species of stones. We use the word in the sense assigned by him.

Shorl is found abundantly in mountains, either massive or crystallized, in three or nine sided prisms, often terminated by three sided summits. The sides of the crystals are longitudinally streaked. Its texture is foliated. Its fracture conchoidal. Lustre 2. Opaque. Hardness 10. Sp. gr. 2.92 to 3.212. Colour black. Streak grey. It does not become electric by heat. When heated to redness, its colour becomes brownish red; and at 127° Wedgewood, it is converted into a brownish compact enamel ‡. According to Wiegleb, it is composed of

‡ Ibid. i. 166.

41.25 alumina,
34.16 silica,
20.00 iron,
5.41 manganese.
———
100.82 §

§ Crell's Beiträge, 1. Bandes. 4. Stück, p. 21.

47 Granatite.

SPECIES 3. Granatite.

Staurotide of Hauy—*Pierre de Croix* of De Lisle—*Staurolithe* of Lametherie.

We have adopted from Mr Vauquelin the term *granatite* to denote this stone, because all the other names are ambiguous, having been applied to another mineral possessed of very different properties.

Granatite is found in Galicia in Spain, and Britanny in France. It is always crystallized in a very peculiar form; two six-sided prisms interfect each other, either at right angles or obliquely ¶. Hence the name *crossstone*, by which it was known in France and Spain *. Mr Hauy has proved, in a very ingenious manner, that the primitive form of the granatite is a rectangular prism, whose bases are rhombs, with angles of 129½° and 50½°; and that the height of the prism is to the greater diagonal of a rhomb as 1 to 6; and that its integrant molecules are triangular prisms, similar to what would be obtained by cutting the primitive crystal in two, by a plane passing vertically through the shorter diagonal of the rhomboidal base. From this structure he has demonstrated the law of the formation of the cruciform varieties †. The colour of granatite is greyish or reddish brown.

¶ Fig. 10. * Romé de Lisle, ii. 435.

Simple Stones.

† Ann. de Chim. vi. 142.

According to the analysis of Vauquelin, it is composed of

47.06 alumina,
30.59 silica,
15.30 oxide of iron,
3.00 lime.
———
95.95 ‡.

‡ Ibid. xxx. 106.

48 G. VI. 2. SAI. Tourmaline.

GENUS VI. 2. SAI.

SPECIES 4. Tourmaline (z).

This stone was first made known in Europe by specimens brought from Ceylon; but it is now found frequently forming a part of the composition of mountains. It is either in amorphous pieces, or crystallized in three or nine side prisms, with four-sided summits.

Its texture is foliated: Its fracture conchoidal. Internal lustre 2 to 3. Transparency 3 to 4; sometimes only 2 (A). Causes only single refraction §. Hardness 9 to 11. Sp. gr. 3.05 to 3.155. Colour brown, often so dark that the stone appears black; the brown has also sometimes a tint of green, blue, red, or yellow.

§ Hauy, Jour. de Min. N° xxviii. 265.

When heated to 200° Fahrenheit, it becomes electric; one of the summits of the crystal negatively, the other positively ¶. It reddens when heated; and is fusible *per se* with intumescence into a white or grey enamel.

¶ Æpinus.

A specimen of the tourmaline of Ceylon, analysed by Vauquelin, was composed of

40 silica,
39 alumina,
12 oxide of iron,
4 lime,
2.5 oxide of manganese.
———
97.5 *.

* Ann. de Chim. xxx. 105.

49 Argentine felspar.

SPECIES 5. Argentine felspar †.

† Kirwan, i. 327.

This stone was discovered by Mr Dodun in the black mountains of Languedoc. It is either amorphous, or crystallized in rhomboidal tables, or six or eight sided prisms. Its texture is foliated. Fragments rectangular. Laminæ inflexible. Internal lustre 4. Transparency 2. Colour white; two opposite faces of the crystals are silver white, two others dead white. Hardness of the silvery laminæ 6, of the rest 9. Brittle. Sp. gr. 2.5. When the flame of the blow-pipe is directed against the edges of the crystal (stuck upon glass), it easily melts into a clear compact glass; but when the flame is directed against the faces, they preserve their lustre, and the edges alone slowly melt.

According to the analysis of Dodun, it is composed of

46 silica,
36 alumina,
16 oxide of iron,
—
98

When this stone is exposed to the atmosphere, it is apt

(z) *Kirw.* I. 271.—*Berg.* II 118. and V. 402.—*Gerhard. Mem. Berlin*, 1777. p. 14.—*Hauy Mem. Par.* 1784, 270.—*Wilson Phil. Trans.* XLI. 308.—*Æpinus. Recueil sur la Tourmaline.* See also *La Porterie. Le Saphir, l'Oeil de Chat, et la Tourmaline de Ceylon demasqués.*

(A) And when black only 1.

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apt to decay: Its ſurface becomes irideſcent, and at laſt changes to ochre yellow: Its ſpecific gravity is 2.3 or 2.212; and when breathed upon, it gives out an earthy ſmell.

50
Mica.

SPECIES 6. MICA *.

* *Kirw.* i. 210—*Gmelin, Nov. Com. Petropol.* xii. 549.

This ſtone forms an eſſential part of many mountains, and has been long known under the names of *glacies mariæ* and *Muſcovy glaſs*. It conſiſts of a great number of thin laminæ adhering to each other, ſometimes of a very large ſize. Specimens have been found in Siberia nearly $2\frac{1}{2}$ yards ſquare (B).

It is ſometimes cryſtallized: Its primitive form is a rectangular priſm, whoſe baſes are rhombs, with angles of 120° and 60° †: Its integrant molecule has the ſame form. Sometimes it occurs in rectangular priſms, whoſe baſes alſo are rectangles, and ſometimes alſo in a ſhort ſix-ſided priſms ‡; but is much more frequently in plates or ſcales of no determinate figure or ſize §.

† Fig. 11.

‡ Fig. 12.

§ *Hauy, Jour. de Min.* N° xxviii. 296.

Its texture is foliated. Its fragments flat. The lamellæ flexible, and ſomewhat elaſtic. Luſtre metallic, from 3 to 4. Tranſparency of ~~the laminæ~~ 3 or 4, ſometimes only 2 (C). Hardneſs 6. Very tough. Often abſorbs water. Sp. gr. from 2.6546 to 2.9342. Feels ſmooth, but not greaſy. Powder feels greaſy. Colour, when pureſt, ſilver white or grey; but it occurs alſo yellow, greeniſh, reddiſh, brown, and black. Mica is fuſible by the blow-pipe into a white, grey, green, or black, enamel; and this laſt is attracted by the magnet (D). Spaniſh wax rubbed by it becomes negatively elictric ¶.

¶ *Ibid.*

A ſpecimen of mica, analyſed by Vauquelin, contained

50.00	ſilica,
35.00	alumina,
7.00	oxide of iron.
1.35	magneſia,
1.33	lime,
94.68 *	

* *Ibid.* 302.

Mica has long been employed as a ſubſtitute for glaſs. A great quantity of it is ſaid to be uſed in the Ruſſian marine for panes to the cabin windows of ſhips; it is preferred, becauſe it is not ſo liable as glaſs to be broken by the agitation of the ſhip.

51
Talc.

SPECIES 7. TALC †.

* *Kirw.* i. 150—*Pott. Mem. Berl.* 1746, p. 65.

This ſtone has a very ſtrong reſemblance to mica, and was long conſidered as a mere variety of that mineral. It occurs ſometimes in ſmall looſe ſcales, and ſometimes in an indurated form; but it has not hitherto been found cryſtallized.

Its texture is foliated. The lamellæ are flexible, but not elaſtic. Its luſtre is from 2 to 4. Tranſparency from 2 to 4. Hardneſs 4 to 6. Sp. gr. when indurated, from 2.7 to 2.8. Feels greaſy. Colour moſt commonly whitiſh or greeniſh. Spaniſh wax rubbed with it becomes *poſitively* electric ‡.

‡ *Hauy, Jour. de Min.* N° xxviii. 291.

Variety 1. Scaly talc.

Talcite of Kirwan.

This variety occurs under the form of ſmall ſcales, ſcarcely cohering. Luſtre 3 to 4. Very light. Adheres to the fingers. When rubbed upon the ſkin, it gives it a gloſs. Colour white, with a ſhade of red or green; ſometimes leek green.

Simple Stones.

Variety 2. Common talc.

Venetian talc.

This variety often occurs in oblong nodules. Luſtre, nearly metallic, 4. Tranſparency 2 to 3; when very thin 4. Hardneſs 4 to 5. Colour white, with a ſhade of green or red; or apple green, verging towards ſilver white. By tranſmitted light green.

Variety 3. Shiſtoſe talc.

Its ſtructure is ſlaty. Fracture hackly and long ſplintery. Eaſily crumbles when rubbed in the fracture. External luſtre 2 to 3; internal, 1: but ſometimes, in certain poſitions, 3. Colour grey, with a ſhade of white, green or blue. Becomes white and ſcaly when expoſed to the air.

A ſpecimen of *common talc*, analyſed by Mr Chenevix, contained

48.0	ſilica,
37.0	alumina,
6.0	oxide of iron,
1.5	magneſia,
1.5	lime,
5.0	water,
99.0 §	

§ *Ann. de Chim.* xxviii. 200.

52
Baſaltine.

SPECIES 8. Baſaltine ¶.

¶ *Kirw.* i. 219.

Baſaltic hornblende of Werner—*Actinote* of Hauy—*Zillertite* of Lametherie—*Shorl priſmatique hexagone* of Sauſſure.

This ſtone is found commonly in baſaltic rocks; hence its name, which we have borrowed from Mr Kirwan. It is cryſtallized, either in rhomboidal priſms, or ſix or eight ſided priſms, terminated by three-ſided pyramids. Its texture is foliated. Its fracture uneven. Luſtre 3. Tranſparency, when in very thin plates, 1. Hardneſs from 9 to 10. Sp. gr. 3.333. Colour black, dark green, or yellowiſh green. Streak white. Tranſmits a reddiſh yellow light. Before the blow-pipe, it melts into a greyiſh coloured enamel, with a tint of yellow *. A ſpecimen, ſeemingly of this ſtone, analyſed by Bergman, contained

* *Le Lievre, Jour. de Min.* N° xxviii. 269.

58	ſilica,
27	alumina,
9	iron,
4	lime,
1	magneſia,
99 †	

† *Berg.* iii. 207.

53
Hornblende.

SPECIES 9. Hornblende ‡.

‡ *Kirw.* i. 213.

Amphibole of Hauy (E).

This ſtone enters into the compoſition of various mountains. Its texture is very conſpicuouſly foliated. Fracture conchoidal. Fragments often rhomboidal. Luſtre 2. Opaque. Hardneſs 5 to 9. Tough. Sp. gr. 2.922 to 3.41. Colour black, blackiſh green, olive green,

(B) *Hiſt. General de Voyages*, T. XVIII. 272, quoted by Hauy *Jour. de Min.* N° XXVIII. 299.

(C) Black mica is often nearly opaque.

(D) *Hauy, ibid.* p. 295. Bergman, however, found pure mica infuſible *per ſe*; and this has been the caſe with all the ſpecimens of Muſcovy glaſs which we have tried.

(E) We ſuſpect, that under this name Mr Hauy comprehends *ſhorl* alſo.

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green, or leek green. Streak greenifh. It neither becomes electric by friction nor heat*. Before the blow-pipe it melts into a black glafs. A fpecimen of black hornblende, analyfed by Mr Hermann, was compofed of

* Hauy, Jour. de Min. N° xxviii. 267.

37 filica,
27 alumina,
25 iron,
5 lime,
3 magnefia.

97 †

† Beob. der Berlin, 5. Band. 317

SPECIES 10. Refplendent Hornblende.

54 Refplendent hornblende.

There are two minerals which Werner confiders as varieties of hornblende, and Mr. Kirwan as conftituting a diftinct fpecies These till future analyfes decide the point, we fhall place here under the name of refplendent hornblende, the name given them by Mr Kirwan; and we fhall defcribe them feparately.

Variety 1. Labradore hornblende.

Texture, curved foliated. Luftre, in fome pofitions, 0; in others metallic, and from 3 to 4. Opaque. Hardnefs 8 to 9. Sp. gr. from 3.35 to 3.434. Colour, in moft pofitions, greyifh black; in others, it reflects a ftrong iron grey, fometimes mixed with copper red.

Variety 2. Shiller fpar ‡.

‡ Kirw. i. 221.

Texture foliated. Luftre metallic, 4. Tranfparency, in thin pieces, 1. Hardnefs 8 to 9. Sp. gr. 2.882. Colour green, often with a fhade of yellow; alfo golden yellow. In fome pofitions it reflects white, grey, or yellow. At 141° Wedgewood, hardened into a porcelain mafs. A fpecimen, analyfed by Gmelin, was compofed of

43.7 filica,
17.9 alumina,
23.7 iron,
11.2 magnefia.

96.5 §

§ Berghaukunde, 1 Band. p. 92.

It has been found in the Hartz, ftuck in a ferpentine rock.

55. Obfidian.

SPECIES 11. Obfidian *.

* Kirw. i. 264.

Iceland agate.

This ftone is found either in detached maffes, or forming a part of the rocks which compofe many mountains. It is ufually invefted with a grey or opaque cruft. Its fracture is conchoidal. Its internal luftre 3. Tranfparency 1. Hardnefs 10. Sp. gr. 2.348. Colour black or greyifh black; when in very thin pieces, green. It melts into an opaque grey mafs. According to Bergman, it is compofed of

69 filica,
22 alumina,
9 iron.

100 †

† Berg. iii. 204.

SPECIES 12. Petrilite ‡.

56 Petrilite.

‡ Kirw. i. 325.

Cubic felfpar.

This ftone is found in the mafs of mountains. It is amorphous. Texture foliated. Fracture fplintery. Fragments cubic, or inclining to that form; their faces unpolifhed. Luftre 2. Tranfparency partly 2, partly 1. Hardnefs 9. Sp. gr. 3.081. Colour reddifh brown. Does not melt at 160° Wedgewood.

SPECIES 13. Felfite §.

57 Felfite

§ Kirw. i. 326.

Compact felfpar.

This ftone alfo forms a part of many mountains, and is amorphous. Texture fomewhat foliated. Fracture uneven, approaching to the fplintery. Luftre 1. Tranfparency fcarce 1. Hardnefs 9. Colour azure blue, and fometimes brown and green Streak white. Before the blow-pipe, whitens and becomes rifty; but is infufible *per fe*.

Simple Stones.

GENUS VII. SAP.

SPECIES 1. Felfpar *.

58 G. VII. SAP. Felfpar.

This ftone forms the principal part of many of the higheft mountains. It is commonly cryftallized. Its primitive form, according to De Lifle, is a rectangular prifm, whofe bafes are rhombs, with angles of 65° and 115†°. Sometimes the edges of the prifm are wanting, and faces in their place; and fometimes this is the cafe alfo with the acute angles of the rhomb. For a defcription and figure of thefe, and other varieties, we refer the reader to *Romé de Lifle*‡, *Mr Hauy* §, and *Mr Pini* *.

* Kirw. i. 316. and Jour. de Phyf. paffim.

† Fig. 13. and 14.

‡ Cryftall. ii. 461.

Its texture is foliated. Its crofs fracture uneven. Fragments rhomboidal, and commonly fmooth and polifhed on four fides. Luftre of the polifhed faces often 3. Tranfparency from 3 to 1. Hardnefs 9 to 10. Sp. gr. from 2.437 to 2.7. Gives a peculiar odour when rubbed. It is made electric with great difficulty by friction. Fufible *per fe* into a more or lefs tranfparent glafs. When cryftallized, it decrepitates before the blow-pipe.

§ Mem. Par. 1784, p. 273.

* Sur de Nouvelle Chryftallifation, &c. 8.

Variety 1. Pure Felfpar.

Moon ftone—Adularia.

This is the pureft felfpar hitherto found. It occurs in Ceylon and Switzerland; and was firft mentioned by Mr Sage. Luftre nearly 3. Tranfparency 2 to 3. Hardnefs 10. Sp. gr. 2.559. Colour white; fometimes with a fhade of yellow, green, or red. Its furface is fometimes iridefcent.

Variety 2. Common Felfpar.

Luftre of the crofs fracture 0; of the fracture, in the direction of the laminæ, from 3 to 1. Tranfparency 2 to 1. Colour moft commonly flefh red; but often bluifh grey, yellowifh white, milk white, brownifh yellow; and fometimes blue, olive green, and even black.

Variety 3. Labradore felfpar.

This variety was difcovered on the coaft of Labradore by Mr Wolfe; and fince that time it has been found in Europe. Luftre 2 to 3. Tranfparency from 1 to 3. Sp. gr. from 2.67 to 2.6925. Colour grey. In certain pofitions, fpots of it reflect a blue, purple, red, or green colour.

Variety 4. Continuous felfpar.

This variety moft probably belongs to a different fpecies; but as it has not hitherto been analyfed, we did not think ourfelves at liberty to alter its place.

It is found in large maffes. Texture earthy. Fracture uneven, fometimes fplintery. Luftre 0. Tranfparency 1. Hardnefs 10. Sp. gr. 2.609. Colour reddifh grey, reddifh yellow, flefh red.

A fpecimen of green felfpar from Siberia, analyfed by Vauquelin, contained

62.83 filica,
17.02 alumina,
16.00 potafs,
3.00 lime,
1.00 oxide of iron.

99.85 †

† Ann. de Chim. xxx. 106.

Earths and Stones.

59 Lepidolite.

SPECIES 2. Lepidolite (F).

Lilalite.

This stone appears to have been first observed by the Abbé l'oda, and to have been first described by De Born *. Hitherto it has only been found in Moravia in Germany, and Sudermania in Sweden †. There it is mixed with granite in large amorphous masses. It is composed of thin plates, easily separated, and not unlike those of mica ‡ Lustre, pearly 3. Transparency between 1 and 2. Hardness 4 to 5. Not easily pulverised §. Sp. gr. from 2.816 * to 2.8549 †. Colour of the mass, violet blue; of the thin plates, silvery white. Powder white, with a tint of red ‡ Before the blowpipe, it froths, and melts easily into a white semitransparent enamel, full of bubbles. Dissolves in borax with effervescence, and communicates no colour to it §. Effervesces slightly with soda, and melts into a mass spotted with red. With microcosmic salt, it gives a pearl coloured globule *.

* *Crell's Annals*, 1791, ii 196.
† *Beyer, Ann. de Chim.* xxix. 108.
‡ *Le Lievre, Jour. de Min.* N° li. 219
§ *Ibid.*
* *Klaproth.*
† *Hauy*
‡ *Le Lievre, Jour de Min.* No li. 219.
§ *Ibid.*
* *Klaproth, Ann. de Chim.* xxii. 37.

This stone was first called lilalite from its colour, that of the *lily*. Klaproth, who discovered its component parts, gave it the name of *lepidolite* (G).

It is composed of

53	silica,
20	alumina,
18	potash,
5	fluat of lime,
3	oxide of manganese,
1	oxide of iron.
100 †	

† *Vauquelin, Ann. de Chim.* xxx. 105.

60 Leucite.

SPECIES 3. Leucite ‡

Vesuvian of Kirwan—*White Garnet* of Vesuvius.

‡ *Kirw.* i. 285.

This stone is usually found in volcanic productions, and is very abundant in the neighbourhood of Vesuvius. It is always crystallized. The primitive form of its crystals is either a cube or a rhomboidal dodecahedron, and its integrant molecules are tetrahedrons; but the varieties hitherto observed are all polyhedrons: The most common has a spheroidal figure, and is bounded by 24 equal and similar trapeziods §; sometimes the faces are 12, 18, 36, 54, and triangular, pentagonal, &c. For a description and figure of several of these, we refer the reader to Mr Hauy *. The crystals vary from the size of a pin-head to that of an inch.

§ Fig. 15.
* *Jour. de Min.* N° xxvii. 185.

The texture of the leucite is foliated. Its fracture somewhat conchoidal. Lustre 3; when in a state of decomposition 0. Transparency 3 to 2; when decomposing 0. Hardness 8 to 10; when decomposing 5 to 6. Sp. gr. 2.4648. Colour white, or greyish white (H). Its powder causes syrup of violets to assume a green colour †.

† *Vauquelin, Jour. de Min.* N° xxxix. 165.

It is composed, as Klaproth has shewn, of

54	silica,
23	alumina,
22	potash.
99 (I)	

Simple Stones.

It was by analysing this stone that Klaproth discovered the presence of potash in the mineral kingdom; which is not the least important of the numerous discoveries of that accurate and illustrious chemist.

Leucite is found sometimes in rocks which have never been exposed to volcanic fire; and Mr. Dolomieu has rendered it probable, from the substances in which it is found, that the leucite of volcanoes has not been formed by volcanic fire, but that it existed previously in the rocks upon which the volcanoes have acted, and that it was thrown out unaltered in fragments of these rocks ‡.

‡ *Jour. de Min.* N° xxxix. 177.

GENUS VIII. SAG.

61 G.VIII. SAG Emerald.

SPECIES 1. Emerald (K).

This stone has hitherto been only found crystallized. The primitive form of its crystals is a regular six-sided prism; and the form of its integrant molecules is a triangular prism, whose sides are squares, and bases equilateral triangles §. The most common variety of its crystals is the regular six-sided prism, sometimes with the edges of the prism or of the bases, or the solid angles, or both wanting *, and small faces in their place †. The sides of the prism are generally channelled.

§ *Hauy, Jour. de Min.* N° xix 72
* Fig. 16.
† *Romé de Lisle*, ii. 245. and *Hauy, ibid.*

Its texture is foliated. Its fracture conchoidal. Lustre usually from 3 to 4. Transparency from 2 to 4. Causes a double refraction. Hardness 12. Sp. gr. 2.65 to 2.775. Colour green. Becomes electric by friction, but not by heat. Its powder does not phosphoresce when thrown on a hot iron ‡. At 150° Wedgewood it melts into an opaque coloured mass. According to Dolomieu, it is fusible *per se* by the blow-pipe *.

‡ *Dolomieu, Jour. de Min.* N° xviii. 19.
* *Ibid.*

This mineral was formerly subdivided into two distinct species, the *emerald*, and *beryl* or *aqua marina*. Hauy demonstrated, that the emerald and beryl correspond exactly in their structure and properties, and Vauquelin found that they were composed of the same ingredients; henceforth, therefore, they must be considered as varieties of the same species.

The variety formerly called *emerald* varies in colour from the pale to the perfect green. When heated to 120° Wedgewood, it becomes *blue*, but recovers its colour when cold. A specimen, analysed by Vauquelin, was composed of

64.60	silica,
14.00	alumina,
13.00	glucina,
3.50	oxide of chromum,
2.56	lime,
2.00	moisture or other volatile ingredient.
99.66 †	

† *Ann. de Chim.* xxvi. 264.

The *beryl* is of a greyish green colour, and sometimes blue, yellow, and even white: sometimes different colours appear in the same stone ‡ It is found in Ceylon, different parts of India, Brazil, and especially in Siberia and Tartary, where its crystals are sometimes a foot long §.

‡ *Dolomieu, ibid.*
§ *Ibid.*

(F) *Kirw.* I. 208.—*Karsten. Beob. der Berlin*, 5 *Band.* 71.—*Klaproth Beiträge*, I. 279. *and* II. 191.

(G) That is, *scale stone*, or stone composed of scales: From λεπις *the scale of a fish*, and λιθος *a stone*.

(H) Hence the name leucite, from λευκος, *white*.

(I) See *Jour. de Min.* N° XXVII. 164. and 201. and *Klaproth's Beiträge*, II. 39.

(K) *Kir.* I. 247. and 248.—*Dolomieu. Magazin Encyclopædique*, II. 17. and 145.; and *Jour de Min.* N° XVIII. 19.—*Klaproth Beiträge*, II.

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long. A specimen of beryl, analysed by Vauquelin, contained

69	silica,
13	alumina,
16	glucina,
1.5	oxide of iron.
99.5 *	

It was by analysing this stone that Vauquelin discovered the earth which he called *glucina*.

* Ann. de Chim. xxviii. 168.

62 G. IX. SAB Staurolite.

GENUS IX. SAB.

SPECIES 1. Staurolite †.

† Kirw. i. 282.

Andreolite of Lametherie and Hauy—*Hyacinthe blanche cruciforme*, var. 9. of Romé de Lisle.

This stone has been found at Andreasberg in the Hartz. It is crystallized, and the form of its crystals has induced mineralogists to give it the name of *cross-stone*. Its crystals ‡ are two four-sided flattened prisms, terminated by four-sided pyramids, intersecting each other at right angles: the plane of intersection passing longitudinally through the prisms (L).

‡ Fig. 17.

Its texture is foliated. Its lustre waxy, 2. Transparency from 1 to 3. Hardness 9. Brittle. Sp. gr. 2.355 to 2.361. Colour milk white. When heated slowly, it loses 0.15 or 0.16 parts of its weight, and falls into powder. It effervesces with borax and microcosmic salt, and is reduced to a greenish opaque mass. With soda it melts into a frothy white enamel. When its powder is thrown on a hot coal, it emits a greenish yellow light §.

§ Hauy, Jour. de Min. N° xxviii. 280.

A specimen analysed by Westrum was composed of

44	silica,
20	alumina,
20	barytes,
16	water.
100	

Klaproth found the same ingredients, and nearly in the same proportions *.

* Beiträge, ii. 80.

A variety of staurolite has been found only once, which has the following peculiarities.

Its lustre is pearly, 2. Sp. gr. 2.361. Colour brownish grey. With soda it melts into a purplish and yellowish frothy enamel. It is composed, according to Westrum, of

47.5	silica,
12.0	alumina,
20.0	barytes,
16.0	water,
4.5	oxides of iron and manganese.
100.0	

63 G. X. ASL. Chrysoberyl.

GENUS X. 1. ASL.

SPECIES 1. Chrysoberyl †.

† Kirw. i. 261.

Oriental chrysolite of jewellers—*Cymophane* of Hauy.

Hitherto this stone has been found only in Brazil, the island of Ceylon, and as some affirm near Nortschink in Siberia. Werner first made it a distinct species, and gave it the name which we have adopted. It is usually found in round masses about the size of a pea, but it is sometimes also crystallized. The primitive form of its crystals is a four-sided rectangular prism, whose height is to its breadth as $\sqrt{3}$ to 1, and to its thickness as $\sqrt{2}$ to 1 *. The only variety hitherto observed is an eight-sided prism, terminated by six-sided summits †. Two of the faces of the prism are hexagons, two are rectangles, and four trapeziums; two faces of the summits are rectangles, and the other four trapeziums. Sometimes two of the edges of the prism are wanting, and small faces in their place ‡.

Simple Stones.

* Fig. 18.
† Fig. 19.
‡ Hauy, Jour. de Min. N° xxi. 5.

Its texture is foliated. Laminæ parallel to the faces of the prism. Lustre 3 to 4. Transparency 3 to 4. Causes single refraction. Hardness 12. Sp. gr. from 3.698 § to 3.7961 *. Colour yellowish green, surface sparkling. It is infusible by the blow-pipe *per se*, and with soda.

§ Werner.
* Hauy.

A specimen of chrysoberyl, analysed by Klaproth, was composed of

71.5	alumina,
18.0	silica,
6.0	lime,
1.5	oxide of iron.
97.0 †	

† Beiträge.

64 G. X. 2. SAL. Hyalite.

GENUS X. 2. SAL.

SPECIES 2. Hyalite *.

This stone is frequently found in trap. It occurs in grains, filaments, and rhomboidal masses. Texture foliated. Fracture uneven, inclining to conchoidal. Lustre glassy (M), 2 to 3. Transparency 2 to 3; sometimes, tho' seldom, it is opaque. Hardness 9. Sp. gr. 2.11 †. Colour pure white. Infusible at 150° Wedgewood; but it yields to soda ‡. According to Mr Link, it is composed of

* Kirw. i. 296.
† Kirwan.
‡ Id.

57	silica,
18	alumina,
15	lime.
90	and a very little iron §.

§ Crell's Annals, 1790. 2 Band. 232

65 Ædelite.

Species 3. Ædelite *.

This stone has hitherto been found only in Sweden at Mosseberg and Ædelfors. From this last place Mr Kirwan, who first made it a distinct species, has given it the name which we have adopted. It was first mentioned by Bergman †. Its form is tuberose and knotty. Texture striated; sometimes resembles quartz. Lustre from 0 to 1. Sp. gr. 2.515 after it has absorbed water ‡. Colour light grey, often tinged red; also yellowish brown, yellowish green, and green. Before the blow-pipe it intumesces and forms a frothy mass. Acids convert it into a jelly §. A specimen from Mosseberg, analysed by Bergman, contained

* Kirw. i. 276.
† Opusc. vi. 101.
‡ See Kirwan's Min. i. 276.
§ Berg. iii. 227.

69	silica,
20	alumina,
8	lime,
3	water.
100 *	

* Opusc. vi. 101.

A specimen from Ædelfors yielded to the same chemist

62	silica,
18	alumina,
17	lime,
4	water.
100 †	

† Ibid.

(L) See *Gillot*, *Jour. de Phys.* 1793, p. 1 and 2.

(M) Hence probably the name *hyalite*, which was imposed by Werner from ὕαλος, and λίθος, *a stone*.

Earths and Stones.

66 G. X. 3. SAWL. Zeolite.

GENUS X. 3. SAWL.

SPECIES 4. Zeolite (N).

This ftone was firft defcribed by Cronftedt in the Stockholm Tranfactions for 1756. It is found fometimes amorphous and fometimes cryftallized. The primitive form of its cryftals is a rectangular prifm, whofe bafes are fquares. The moft common variety is a long four-fided prifm, terminated by low four-fided pyramids*.

* Hauy, Jour. de Min. N° xiv. 86.

Its texture is ftriated or fibrous. Its luftre is filky, from 3 to 1. Tranfparency from 2 to 4; fometimes 1. Hardnefs 6 to 8; fometimes only 4. Abforbs water. Sp. gr. 2.07 to 2.3. Colour white, often with a fhade of red or yellow; fometimes brick red, green, blue. When heated, it becomes electric like the tourmaline †. Before the blow-pipe it froths (O), emits a phofphorefcent light, and melts into a white femitranfparent enamel, too foft to cut glafs, and foluble in acids. In acids it diffolves flowly and partially without effervefcence; and at laft, unlefs the quantity of liquid be too great, it is converted into a jelly.

† Hauy, ibid. N° xxviii. 276.

A fpecimen of zeolite (P), analyfed by Vauquelin, contained

53.00	filica,
27.00	alumina,
9.46	lime,
10.00	water.
99.46 ‡.	

‡ Ibid. N° xliv. 576.

67 Stilbite.

SPECIES 5. Stilbite.

This ftone was firft formed into a diftinct fpecies by Mr Hauy. Formerly it was confidered as a variety of zeolite.

The primitive form of its cryftals is a rectangular prifm, whofe bafes are rectangles. It cryftallizes fometimes in dodecahedrons, confifting of a four-fided prifm with hexagonal faces, terminated by four-fided fummits, whofe faces are oblique parallelograms; fometimes in fix-fided prifms, two of whofe folid angles are wanting, and a fmall triangular face in their place *.

* Hauy, Jour. de Mim. N° xiv. 86.

Its texture is foliated. The laminæ are eafily feparated from each other; and are fomewhat flexible. Luftre pearly, 2 or 3 (Q). Hardnefs inferior to that of zeolite, which fcratches ftilbite. Brittle. Sp. gr. 2.500†. Colour pearl white. Powder bright white, fometimes with a fhade of red. This powder, when expofed to the air, cakes and adheres as if it had abforbed water. It caufes fyrup of violets to affume a green colour. When ftilbite is heated in a porcelain crucible, it fwells up and affumes the colour and femitranfparency of baked porcelain. By this procefs it lofes 0.185 of its weight. Before the blow-pipe it froths like borax, and then melts into an opaque white-coloured enamel ‡.

† Hauy, ibid. N° xxviii. 276.

‡ Vauquelin, ibid. N° xxxix. 161.

According to the analyfis of Vauquelin, it is compofed of

52.0	filica,
17.5	alumina,
9.0	lime,
18.5	water.
97.0 *	

Simple Stones.

* Ibid. 164.

68 Analcime.

SPECIES 6. Analcime.

This ftone, which was difcovered by Mr Dolomieu, is found cryftallized in the cavities of lava. It was firft made a diftinct fpecies by Mr Hauy. Mineralogifts had formerly confounded it with zeolite.

The primitive form of its cryftals is a cube. It is fometimes found cryftallized in cubes, whofe folid angles are wanting, and three fmall triangular faces in place of each; fometimes in polyhedrons with 24 faces. It is ufually fomewhat tranfparent. Hardnefs about 8; fcratches glafs flightly. Sp. gr. above 2. When rubbed, it acquires only a fmall degree of electricity, and with difficulty (R). Before the blow-pipe it melts without frothing, into a white femitranfparent glafs †.

† Hauy, Jour. de Min. N° xiv. 86. and xxviii. 278.

69 G. X. 4. SLA. Lazulite.

GENUS X. 4. SLA.

SPECIES 7. Lazulite ‡.

This ftone, which is found chiefly in the northern parts of Afia, has been long known to mineralogifts by the name of *lapis lazuli*. This term has been contracted into *lazulite* by Mr Hauy; an alteration which was certainly proper, and which therefore we have adopted.

‡ Kirw. i. 283.

Lazulite is always amorphous. Its texture is earthy. Its fracture uneven. Luftre 0. Opaque, or nearly fo. Hardnefs 8 to 9. Sp. gr. 2.76 to 2.945 *. Colour blue (S); often fpotted white from fpecks of quartz, and yellow from particles of pyrites.

* Briffon.

It retains its colour at 100° Wedgewood; in a higher heat it intumefces, and melts into a yellowifh black mafs. With acids it effervefces a little, and if previoufly calcined, forms with them a jelly.

Margraff publifhed an analyfis of lazulite in the Berlin Memoirs for 1758. His analyfis has fince been confirmed by Klaproth, who found a fpecimen of it to contain

46.0	filica,
14.5	alumina,
28.0	carbonat of lime,
6.5	fulphat of lime,
3.0	oxide of iron,
2.0	water.
100.0 †	

† Beiträge, i. 196.

70 G. XI. SALI. Garnet.

GENUS XI. SALI.

SPECIES 1. Garnet (T).

This ftone is found abundantly in many mountains. It is ufually cryftallized. The primitive form of its cryftals

(N) *Kirw.* I. 278.—*Guettard*, IV. 637.—*Bucquet, Mem. Sav. Etrang.* IX. 576.—*Pelletier, Jour. de Phyf.* XX. 420.

(O) Hence the name *zeolite*, given to this mineral by Cronftedt; from ζεω, *to ferment*, λιθος, *a ftone*.

(P) Dr Black was accuftomed to mention, in the courfe of his lectures, that Dr Hutton had difcovered *foda* in zeolite. This difcovery has not hitherto been verified by any other chemical mineralogift.

(Q) Hence the name given to this mineral by Hauy, *ftilbite*, from στιλβω, *to fhine*.

(R) Hence the name *analcime* given it by Hauy, from αναλκις, *weak*.

(S) Hence the name *lazulite*, from an Arabian word *azul*, which fignifies *blue*.

(T) *Kirw.* I. 258.—*Gerhard, Difquifitio phyfico-chymica Granatorum*, &c.—*Pafumot, Jour. de Phyf.* III. 442. —*Wiegleb, Ann. de Chim.* I. 231.

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cryſtals is a dodecahedron whoſe ſides are rhombs, with angles of 78° 31′ 44″, and 120° 28′ 16″. The inclination of the rhombs to each other is 120°. This dodecahedron may be conſidered as a four-ſided priſm, terminated by four-ſided pyramids *. It is diviſible into four parallelopipeds, whoſe ſides are rhombs; and each of theſe may be divided into four tetrahedrons, whoſe ſides are iſoſceles triangles, equal and ſimilar to either of the halves into which the rhomboidal faces of the dodecahedron are divided by their ſhorter diagonal. The integrant molecules of garnet are ſimilar tetrahedrons †. Sometimes the edges of the dodecahedrons are wanting, and ſmall faces in their place; and ſometimes garnet is cryſtallized in polyhedrons, having 24 trapezoidal faces. For a deſcription and figure of theſe, and other varieties of garnet, we refer to *Romé de Liſle* and *Hauy* ‡.

* Fig. 20.
* *De Liſle*, ii. 322. and *Hauy*, *Ann. de Chim.* xvii. 305.
† *Hauy, ibid.* 306.
‡ *Ibid.*

The texture of garnet, as Bergman firſt ſhewed, is foliated §. Its fracture commonly conchoidal. Internal luſtre from 4 to 2. Tranſparency from 2 to 4; ſometimes only 1 or 0. Cauſes ſingle refraction ‖. Hardneſs from 10 to 14. Sp. gr. 3.75 to 4.188. Colour uſually red. Often attracted by the magnet. Fuſible *per ſe* by the blow-pipe.

§ *Opuſc.* ii. 9.
‖ *Hauy, Jour. de Min.* N° xxviii. 260.

Variety 1. Oriental garnet (v).

Internal luſtre 3 to 4. Tranſparency 4. Hardneſs 13 to 14. Sp. gr. 4 to 4.188. Colour deep red, inclining to violet (x).

Variety 2. Common garnet.

Fracture uneven, inclining to the conchoidal. Internal luſtre 2 to 3. Tranſparency from 3 to 0. Hardneſs 10 to 11; ſometimes only 9. Sp. gr. 3.75 to 4. Colour commonly deep red, inclining to violet; ſometimes verging towards black or olive; ſometimes leek green, brown, yellow.

Variety 3. Amorphous garnet.

Structure ſlaty. Luſtre 2. Tranſparency 2 to 1. Hardneſs 11 to 12. Sp. gr. 3.89. Colour browniſh or blackiſh red. Found in Sweden, Switzerland, and the Eaſt Indies.

A ſpecimen of oriental garnet, analyſed by Klaproth, contained

35.75 ſilica,
27.25 alumina,
36.00 oxide of iron,
0.25 oxide of mangaueſe.
―――
99.25*

* *Beiträge*, ii. 26.

A ſpecimen of red garnet, analyſed by Vauquelin, contained

52.0 ſilica,
20.0 alumina,
17.0 oxide of iron,
7.7 lime.
―――
96.7†

† *Jour. de Min.* N° xliv. 575.

A ſpecimen of black garnet yielded to the ſame chemiſt

43 ſilica,
16 alumina,
20 lime,
16 oxide of iron,
4 moiſture.
―――
99‡

‡ *Ibid.* 573.

Simple Stones.

Mr Klaproth found a ſpecimen of Bohemian garnet, compoſed of

40.00 ſilica,
28.50 alumina,
16.50 oxide of iron,
10.00 magneſia,
3.50 lime,
.25 oxide of manganeſe.
―――
98.75*

* *Beiträge*, ii. 21.

SPECIES 2. Thumerſtone †.

71 Thumerſtone.

Yanolite of Lamatherie—*Axinite* of Hauy.

This ſtone was firſt deſcribed by Mr Schreber, who found it near Balme d'Auris in Dauphiné, and gave it the name of *ſhorl violé* ‡. It was afterwards found near Thum in Saxony, in conſequence of which Werner called it *thumerſtone*.

† *Kirw.* i. 273.—*Pelletier, Journ. de Phyſ.* xxvi. 66.
‡ *De Liſle*, ii. 353.

It is ſometimes amorphous; but more commonly cryſtallized. The primitive form of its cryſtals is a rectangular priſm, whoſe baſes are parallelograms with angles of 101° 32′ and 78° 28′ §. The moſt uſual variety is a flat rhomboidal parallelopiped, with two of its oppoſite edges wanting, and a ſmall face in place of each ‖. The faces of the parallelopiped are generally ſtreaked longitudinally ¶.

§ *Hauy, Jour. de Min.* N° xxviii. 264.
‖ Fig. 21.
¶ *De Liſle, ibid.*

The texture of thumerſtone is foliated. Its fracture conchoidal. Luſtre 2. Tranſparency, when cryſtallized, 3 to 4; when amorphous, 2 to 1. Cauſes ſimple refraction *. Hardneſs 10 to 9. Sp. gr. 3.2956. Colour clove brown; ſometimes inclining to red, green, grey, violet, or black. Before the blow-pipe it froths like zeolite, and melts into a hard black enamel. With borax it exhibits the ſame phenomena, or even when the ſtone is ſimply heated at the end of a pincer †.

* *Hauy, ibid.*
† *Vauquelin, Jour. de Min.* N° xxiii. 1.

A ſpecimen of thumerſtone, analyſed by Klaproth, contained

52.7 ſilica,
25.6 alumina,
9.4 lime,
9.6 oxide of iron with a trace of manganeſe.
―――
97.3‡

‡ *Beiträge*, ii. 126.

A ſpecimen, analyſed by Vauquelin, contained

44 ſilica,
18 alumina,
19 lime,
14 oxide of iron,
4 oxide of manganeſe.
―――
99§

§ *Jour. de Min. ibid.*

SPECIES 3. Prehnite (y).

72 Prehnite.

Though this ſtone had been mentioned by Sage ‖, Romé de Liſle ¶, and other mineralogiſts, Werner was the firſt who properly diſtinguiſhed it from other minerals, and made it a diſtinct ſpecies. The ſpecimen which he examined was brought from the Cape of Good Hope by Colonel Prehn; hence the name *prehnite*, by which he diſtinguiſhed it. It was found near Dunbarton by Mr Grotche *; and ſince that time it has been obſerved in other parts of Scotland.

‖ *Miner.* i. 232.
¶ *Cryſtallog.* ii. 275.
* *Ann. de Chim.* x. 213.

It

(v) This ſeems to be the *carbuncle* (ανθραξ) of Theophraſtus, and the *carbunculus garamanticus* of other ancient writers. See *Hill's Theophraſtus*, περι λιθων, p. 74. and 77.

(x) Hence, according to many, the name *garnet* (in Latin *granatus*), from the reſemblance of the ſtone in colour to the bloſſoms of the pomegranate.

(y) *Kirw.* I. 274.—*Haſſenfratz, Jour. de Phyſ.* XXXII. 81.—*Sage, ibid.* XXXIV. 446.—*Klaproth. Beob. der Berlin*, 2 *Band.* 211. And *Ann. de Chim.* I. 201.

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It is both amorphous and cryſtallized. The cryſtals are in groups, and confuſed: they ſeem to be four-ſided priſms with dihedral ſummits *. Sometimes they are irregular ſix-ſided plates, and ſometimes flat rhomboidal parallelopipeds.

Its texture is foliated. Fracture uneven. Internal luſtre pearly, ſcarcely 2. Tranſparency 3 to 2. Hardneſs 9 to 10. Brittle. Sp. gr. 2.6969 †. Colour apple green, or greeniſh grey. Before the blow-pipe it froths more violently than zeolite, and melts into a brown enamel. A ſpecimen of prehnite, analyſed by Klaproth, was compoſed of

43.83	ſilica,
30.33	alumina,
18.33	lime,
5.66	oxide of iron,
1.16	air and water.
99.31 ‡	

Whereas Mr Haſſenfratz found in another ſpecimen

50.0	ſilica,
20.4	alumina,
23.3	lime,
4.9	iron,
.9	water,
.5	magneſia.
100.0 §	

* *Hauy, Jour. de Min.* N° xxviii. 277.
† *Hauy, ibid.*
‡ *Ann. de Chim.* i. 208.
§ *Ibid.* and *Jour. de Phyſ.* N° xxxii. 81.

SPECIES 4. Thallite.

73 Thallite.

Green ſhorl of Dauphiné of De Liſle ‖.—*Delphinite* of Sauſſure.

This ſtone is found in the fiſſures of mountains; and hitherto only in Dauphiné and on Chamouni in the Alps.

It is ſometimes amorphous, and ſometimes cryſtallized. The primitive form of its cryſtals is a rectangular priſm, whoſe baſes are rhombs with angles of 114° 37′, and 65° 23′ ¶. The moſt uſual variety is an elongated four-ſided priſm (often flattened), terminated by four-ſided incomplete pyramids *; ſometimes it occurs in regular ſix-ſided priſms †. The cryſtals are often very ſlender.

Its texture appears fibrous. Luſtre inconſiderable. Tranſparency 2 to 3, ſometimes 4; ſometimes nearly opaque. Cauſes ſingle refraction. Hardneſs 9 to 10. Brittle. Sp. gr. 3.4529 to 3.46. Colour dark green (z). Powder white or yellowiſh green, and feels dry. It does not become electric by heat. Before the blow-pipe, froths and melts into a black ſlag. With borax melts into a green bead ‡.

A ſpecimen of thallite, analyſed by Mr Deſcotils, contained

37	ſilica,
27	alumina,
17	oxide of iron,
14	lime,
1.5	oxide of mangancſe.
96.5 §	

‖ *Cryſtallog.* ii. 401.
¶ *Hauy, Jour. de Min.* N° xxviii. 271.
* Fig. 22.
† *Romé de Liſle, ibid.* and *Hauy, Jour. de Min.* N° xxx. 415.
‡ *Hauy,* and *Deſcotils, ibid.*
§ *Ibid.* N° xxx. 420.

GENUS XII. I. AMS.

SPECIES I. Cyanite *.

Sappare of Sauſſure.

Simple Stones.

74 G. XII. AMS. Cyanite.

This ſtone was firſt deſcribed by Mr Sauſſure the ſon, who gave it the name of *ſappare* †. It is commonly found in granite rocks. The primitive form of its cryſtals is a four-ſided oblique priſm, whoſe ſides are inclined at an angle of 103°. The baſe forms with one ſide of the priſm an angle of 103°; with another an angle of 77°. It is ſometimes cryſtallized in ſix-ſided priſms ‡.

Its texture is foliated. Laminæ long. Fragments long, ſplintery. Luſtre pearly, 2 to 3. Tranſparency of the laminæ 3. Cauſes ſingle refraction §. Hardneſs 6 to 9. Brittle. Sp. gr. from 3.092 to 3.622 ‖. Feels ſomewhat greaſy. Colour milk white, with ſhades of ſky or pruſſian blue (A); ſometimes bluiſh grey; ſometimes partly bluiſh grey, partly yellowiſh or greeniſh grey.

Before the blow-pipe it becomes almoſt perfectly white; but does not melt. According to the analyſis of Sauſſure, it is compoſed of

66.92	alumina,
13.25	magneſia,
12.81	ſilica,
5.48	iron,
1.71	lime.
100.17 *	

Cyanite has alſo been analyſed by Struvius and Hermann, who agree with Sauſſure as to the ingredients; but differ widely from him and one another as to the proportions.

Struvius.		Hermann.	
5.5	- - -	30	alumina,
30.5	- - -	39	magneſia,
51.5	- - -	23	ſilica,
5.0	- - -	2	iron,
4.0	- - -	3	lime.
96.5 †		97 ‡	

* *Kirw.* i. 209.—*Sage, Jour. de Phyſ.* xxxv. 39.
† *Jour. de Phyſ.* xxxiv. 213.
‡ *Hauy, Jour. de Min.* N° xxviii. 282.
§ *Hauy, ibid.*
‖ *Kirwan.*
* *Jour. de Phyſ. ibid.*
† *Crell's Annals,* 1790.
‡ *Ibid.*

GENUS XII. 2. MSA.

SPECIES 2. Serpentine (B).

75 G. XII. 2. MSA. Serpentine.

This ſtone is found in amorphous maſſes. Its fracture is ſplintery. Luſtre 0. Opaque. Hardneſs 6 to 7. Sp. gr. 2.2645 to 2.709. Feels rather ſoft, almoſt greaſy. Generally emits an earthy ſmell when breathed upon. Its colours are various ſhades of green, yellow, red, grey, brown, blue: commonly one or two colours form the ground, and one or more appear in ſpots or veins (C).

Before the blow-pipe it hardens and does not melt.

A ſpecimen of ſerpentine, analyſed by Mr Chenivix, contained

34.5	magneſia,
28.0	ſilica,
23.0	alumina,
4.5	oxide of iron,
0.5	lime,
10.5	water.
101.0 §	

§ *Ann. de Chim.* xxviii. 199.

GENUS

(Z) Hence the name *thallite* given it by Lametherie, from θαλλος, *a green leaf.*

(A) Hence the name *cyanite*, impoſed by Werner.

(B) *Kirw.* I. 156.—*Margraf, Mem. Berlin,* 1759, p. 3.—*Bayen, Jour. de Phyſ.* XIII. 46.—*Mayer, Crell's Annals,* 1789, II. 416.

(C) Hence the name *ſerpentine*, given to the ſtone from a ſuppoſed reſemblance in colours to the ſkin of a ſerpent.

Earths and Stones.

76 G. XIII. MSAI. Potstone. * Kirw. i. 155.

Genus XIII. msai.

Species 1. Potstone *.

This stone is found in nests and beds, and is always amorphous. Its structure is often slaty. Texture undulatingly foliated. Lustre from 1 to 3. Transparency from 1 to 0; sometimes 2. Hardness 4 to 6. Brittle. Sp. gr. from 2.8531 to 3.023. Feels greasy. Sometimes absorbs water. Colour grey with a shade of green, and sometimes of red or yellow; sometimes leek green; sometimes specked with red.

Potstone is not much affected by fire; and has therefore been made into utensils for boiling water; hence its name.

According to Wiegleb, the potstone of Como contains

38	magnesia,
38	silica,
7	alumina,
5	iron,
1	carbonat of lime,
1	fluoric acid.
90	

77 Chlorite. † Kirw. i. 147.

Species 2. Chlorite †.

This mineral enters as an ingredient into different mountains. It is sometimes amorphous, and sometimes crystallized in oblong, four-sided, acuminated crystals. Its texture is foliated. Its lustre from 0 to 2. Opaque. Hardness from 4 to 6; sometimes in loose scales. Colour green.

Variety 1. Farinaceous chlorite.

Composed of scales scarcely cohering, either heaped together, or investing other stones. Feels greasy. Gives an earthy smell when breathed on. Difficult to pulverise. Colour grass green; sometimes greenish brown; sometimes dark green, inclining to black. Streak white. When the powder of chlorite is exposed to the blow-pipe it becomes brown. Before the blow-pipe, farinaceous chlorite froths and melts into a dark brown glass; with borax it forms a greenish brown glass ‡.

‡ Vauquelin, Jour. de Min. No xxxix. 167.

Variety 2. Indurated chlorite.

This variety is crystallized. Lustre 1. Hardness 6. Feel meagre. Colour dark green, almost black. Streak mountain green.

Variety 3. Slaty chlorite.

Structure slaty. Fragments flatted. Internal lustre 1 to 2. Hardness 5. Colour greenish grey, or dark green inclining to black. Streak mountain green.

A specimen of the first variety, analysed by Vauquelin, contained

43.3	oxide of iron,
26.0	silica,
15.5	alumina,
8.0	magnesia,
2.0	muriat of potass,
4.0	water.
98.8 §	

§ Ann. de Chim. xxx. 106.

A specimen of the same variety yielded Mr Hæpner

12.92	oxide of iron,
37.50	silica,
4.17	alumina,
43.75	magnesia,
1.66	lime.
100.0 *	

* Saussure's Voyages, ii. 133.

A specimen of the second variety, analysed by the same chemist, contained

10.15	oxide of iron,
41.15	silica,
6.13	alumina,
39.47	magnesia,
1.50	lime,
1.50	air and water.
99.90 †	

† Crell's Annals, 1790, p. 56.

On the supposition that these analyses are accurate, the enormous difference between them is a demonstration that chlorite is not a chemical combination, but a mechanical mixture.

Simple Stones.

78 G. XIV. SLAM Siliceous-spar.

Genus XIV. slam.

Species 1. Siliceous spar (d).

This stone has been found in Transylvania. It is crystallized in 4 or 6 sided prisms, channelled transversely, and generally heaped together. Its texture is fibrous. Its lustre silky, 2. Its colours white, yellow, green, light blue. According to Bindheim, it contains

61.1	silica,
21.7	lime,
6.6	alumina,
5.0	magnesia,
1.3	oxide of iron,
3.3	water.
99.0 *	

* Berg. vi. 104.

79 G. XV. SAMLI. Argillite. † Kirw. i. 234.

Genus XV. samli.

Species 1. Argillite †.

Argillaceous shistus—Common slate.

This stone constitutes a part of many mountains. Its structure is slaty. Its texture foliated. Fracture splintery. Fragments often tabular. Lustre, most commonly silky, 2; sometimes 0. Transparency from 0 to 1. Hardness from 5 to 8. Sp. gr. from 2.67 to 2.88. Does not adhere to the tongue. Gives a clear sound when struck. Often imbibes water. Streak white or grey. Colour most commonly grey, with a shade of blue, green, or black; sometimes purplish, yellowish mountain green, brown, bluish black: sometimes striped or spotted with a darker colour than the ground.

It is composed, according to Kirwan, of silica, alumina, magnesia, lime, oxide of iron. In some varieties the

(d) Is this the *tremolite* of Lowitz from the lake Baikal in Siberia? If so, the name of the genus ought to be slm; for he found it contain no alumina. According to his analysis, it was composed of

52	silica,
20	lime,
12	carbonat of lime,
12	magnesia,
96	

The

Earths and Stones. the lime is wanting. Several varieties contain a conſiderable quantity of carbonaceous matter.

80 G. XVI. SLACMI. Smaragdite.

Genus XVI. SLACMI.

SPECIES 1. Smaragdite.

This ſtone was called *ſmaragdite* by Mr Sauſſure, from ſome reſemblance which it has to the emerald. Its texture is foliated. The laminæ are inflexible. Fracture even. Hardneſs 7. Colour in ſome caſes fine green, in others it has the grey colour and metallic luſtre of mica: it aſſumes all the ſhades of colour between theſe two extremes *.

* *Hauy, Jour. de Min.* N° xxviii. 272.

According to the analyſis of Vauquelin, it is compoſed of

50.0	ſilica,
13.0	lime,
11.0	alumina,
7.5	oxide of chromum,
6.0	magneſia,
5.5	oxide of iron,
1.5	oxide of copper.
94.5 †	

† *Ann. de Chim.* xxx. 106.

81 G. XVII. SM. Kiffekil.

Genus XVII. SM.

SPECIES I. Kiffekil ‡.

Myrſen—Seafroth.

This mineral is dug up near Konie in Natolia, and is employed in forming the bowls of Turkiſh tobacco pipes. The ſale of it ſupports a large monaſtery of derviſes eſtabliſhed near the place where it is dug. It is found in a large fiſſure ſix feet wide, in grey calcareous earth. The workmen aſſert, that it grows again in the fiſſure §, and puffs itſelf up like froth (E). This mineral, when freſh dug, is of the conſiſtence of wax; it feels ſoft and greaſy; its colour is yellow; its ſp. gr. 1.600 *: when thrown on the fire it ſweats, emits a fetid vapour, becomes hard, and perfectly white.

‡ *Kirwan's Min.* i. 144.

§ *Reignegg. Philoſ. Mag.* iii. 165.

* *Klaproth.*

According to the analyſis of Klaproth, it is compoſed of

50.50	ſilica,
17.25	magneſia,
25.00	water,
5.00	carbonic acid,
.50	lime.
98.25 †	

† *Beiträge,* ii. 172.

82 Steatites.

SPECIES 2. Steatites (F).

Though this mineral was noticed by the ancients, little attention was paid to it by mineralogiſts, till Mr Pott publiſhed his experiments on it in the Berlin Memoirs for 1747.

It is uſually amorphous, but ſometimes it is cryſtallized in ſix-ſided priſms. Its texture is commonly earthy, but ſometimes foliated. Luſtre from 0 to 2. Tranſparency from 0 to 2. Hardneſs 4 to 7. Sp. gr. from 2.61 to 2.794 ‡. Feels greaſy. Seldom adheres to the tongue. Colour uſually white or grey; often with a tint of other colours; the foliated commonly green. Does not melt *per ſe* before the blow-pipe.

‡ *Briſſon.*

Simple Stones.

Variety 1. Semi-indurated ſteatites.

Texture earthy. Fracture ſometimes coarſe ſplintery. Luſtre 0. Tranſparency 0, or ſcarce 1. Hardneſs 4 to 5. Abſorbs water. Takes a poliſh from the nail. Colour white, with a ſhade of grey, yellow, or green; ſometimes pure white; ſometimes it contains dendritical figures; and ſometimes red veins.

Variety 2. Indurated ſteatites.

Fracture fine ſplintery, often mixed with imperfectly conchoidal. External luſtre 2 to 1, internal 0. Tranſparency 2. Often has the feel of ſoap. Abſorbs water. Colour yellowiſh or greeniſh grey; often veined or ſpotted with deep yellow or red.

Variety 3. Foliated or ſtriated ſteatites.

The texture of this variaty is uſually foliated; ſometimes ſtriated. Fragments cubiform. Luſtre 3. Tranſparency 2 to 1. Hardneſs 6 to 7. Colour leek green, paſſing into mountain green or ſulphur yellow. Streak pale greeniſh grey. When heated to redneſs, it becomes grey; and at 147° Wedgewood, it forms a grey porous porcelain maſs *.

* *Kirwan,* i. 155.

A ſpecimen of ſteatites, analyſed by Klaproth, contained

59.5	ſilica,
30.5	magneſia,
2.5	iron,
5.5	water.
98.0 †	

† *Beiträge,* ii. 179.

A ſpecimen of white ſteatites, analyſed by Mr Chenevix, contained

60.00	ſilica,
28.50	magneſia,
3.00	alumina,
2.50	lime,
2.25	iron.
96.25 ‡	

‡ *Ann. de Chim.* xxviii. 200.

83 G. XVIII. MSI. Chryſolite.

Genus XVIII. MSI.

SPECIES I. Chryſolite (G).

Peridot of the French—*Topaz* of the ancients.

The name *chryſolite* was applied, without diſcrimination, to a great variety of ſtones, till Werner defined it accurately, and confined it to that ſtone which the French chemiſts diſtinguiſh by the appellation of *peridot*. This ſtone is the *topaz* of the ancients; their chryſolite is now called *topaz* *.

* *Plinii,* lib. 37. c. 8.

Chryſolite is found ſometimes in unequal fragments, and ſometimes cryſtallized †. The primitive form of its cryſtals is a right angled parallelopiped ‡, whoſe length, breadth, and thickneſs, are as 5, $\surd 8$, $\surd 5$ §.

† Fig. 23.

‡ Fig. 24.

§ *Hauy, Jour. de Min.* N° xxviii. 281.

The texture of the chryſolite is foliated. Its fracture conchoidal. Its internal luſtre from 2 to 4. Its tranſparency from 4 to 2. Cauſes double refraction. Hardneſs

---

The carbonat of lime was only mechanically interpoſed between the fibres of the ſtone. See *Pallas, Neu. Nord. Beiträge, 6 Band,* p. 146.

(E) Hence the name *kiff-kil,* or rather *keff-kelli,* "clay froth," or "light clay."

(F) *Kirw.* I. 151.—*Pott, Mem. Berlin,* 1747, p. 57.—*Wiegleb, Jour. de Phyſ.* XXIX. 60.—*Lavoiſier, Mem. Par.* 1778, 433.

(G) *Kirw.* I. 262.—*Cartheuſer, Min.* 94.—*Dolomieu, Jour. de Min.* N° xxix. 365.—*La Metherie, Nouv. Jour. de Phyſ.* I. 397.

Earths and Stones.

Hardneſs 9 to 10. Brittle. Sp. gr. from 3.265 to 3.45. Colour green. It is infuſible at 150°, but loſes its tranſparency, and becomes blackiſh grey *. With borax it melts without efferveſcence into a tranſparent glaſs of a light green colour. Infuſible with microcoſmic ſalt † and fixed alkali ‡.

* Kir. Min. i. 253.
† Vauquelin, Ann. de Chim. xxi. 97.
‡ Kirw. ibid.

Variety 1. Common chryſolite.

Found in Ceylon, and South America, and in Bohemia, amidſt ſand and gravel §. Luſtre 3 to 4. Tranſparency 4 to 3. Colour yellowiſh green, ſometimes verging to olive green, ſometimes to pale yellow.

§ Coquebert, Jour. de Min. N° xxii. 20.

Variety 2. Olive chryſolite—*Olivine* *.

Found commonly among traps and baſalts; ſometimes in ſmall grains, ſometimes in pretty large pieces; but it has not been obſerved in cryſtals. Luſtre 2 to 3. Tranſparency 3 to 2. Colour olive green.

* Kirwan's Min. i. 263—Le Lievre, Jour. de Phyſ. xxx. 397.

The firſt variety, according to the analyſis of Klaproth, is compoſed of 41.5 magneſia,
38.5 ſilica,
19.0 oxide of iron.

99.0 †

† Klaproth's Beiträge, i. 103.

According to that of Vauquelin, it is compoſed of
51.5 magneſia,
38.0 ſilica,
9.5 oxide of iron.

99.0 ‡

‡ Ann de Chim. ibid.

The ſecond variety, according to the analyſis of Klaproth, is compoſed of 37.58 magneſia,
50.00 ſilica,
11.75 oxide of iron,
.21 lime.

99.54 §

§ Beiträge, i. 112.

84 Jade.

Species 2. Jade (h).

This ſtone was formerly called *lapis naphriticus*, and was much celebrated for its medical virtues. It is found in Egypt, China, America, and in the Siberian and Hungarian mountains. It is ſometimes adhering to rocks, and ſometimes in detached round pieces.

Its ſurface is ſmooth. Its fracture ſplintery. External luſtre 0, or ſcarce 1; internal waxy, 1. Tranſparency from 2 to 1. Hardneſs 10. Not brittle. Sp. gr. from 2.95 to 2.9829; or, according to Sauſſure, to 3 389. Feels greaſy. Looks as if it had imbibed oil. Colour dark leek green, or verging towards blue; in ſome prominences inclining to greeniſh or bluiſh white. When heated it becomes more tranſparent and brittle, but is infuſible *per ſe*. According to Hoepfner, it is compoſed of 47 ſilica,
38 carbonat of magneſia,
9 iron,
4 alumina,
2 carbonat of lime.

100

This is the ſtone in which the inhabitants of New Zealand make into hatchets and other cutting inſtruments.

Simple Stones.

85 G. XIX. SML. Aſbeſtus.

Genus XIX. sml.

species 1. Aſbeſtus (i).

This mineral was well known to the ancients. They even made a kind of cloth from one of the varieties, which was famous among them for its incombuſtibility. It is found abundantly in moſt mountainous countries, and no where more abundantly than in Scotland.

It is commonly amorphous. Its texture is fibrous. Its fragments often long ſplintery. Luſtre from 0 to 2; ſometims 3, and then it is metallic. Tranſparency from 0 to 2. Hardneſs from 3 to 7. Sp. gr. from 2.7 to 0.6806. Abſorbs water. Colour uſually white or green. Fuſible *per ſe* by the blow-pipe.

Variety 1. Common aſbeſtus.

Luſtre 2 to 1. Tranſparency 1. Hardneſs 6 to 7. Sp. gr. 2.577 to 2.7. Feels ſomewhat greaſy. Colour leek green; ſometimes olive or mountain green; ſometimes greeniſh or yellowiſh grey. Streak grey. Powder grey.

Variety 2. Flexible aſbeſtus.

Amiantus.

Compoſed of a bundle of threads ſlightly cohering. Fibres flexible. Luſtre 1 to 2, ſometimes 3. Tranſparency 1 to 2, ſometimes 0. Hardneſs 3 to 4. Sp. gr. before it abſorbs water, from 0.9088 to 2.3134; after abſorbing water, from 1.5662 to 2.3803 *. Feels greaſy. Colour greyiſh or greeniſh white; ſometimes yellowiſh or ſilvery white, olive or mountain green, pale fleſh red, and mountain yellow.

* Briſſon.

Variety 3. Elaſtic aſbeſtus.

Mountain cork.

This variety has a ſtrong reſemblance to common cork. Its fibres are interwoven. Luſtre commonly 0. Opaque. Hardneſs 4. Sp. gr. before abſorbing water, from 0.6806 to 0.9933; after abſorbing water, from 1.2492 to 1.3492. Feels meagre. Yields to the fingers like cork, and is ſomewhat elaſtic. Colour white; ſometimes with a ſhade of red or yellow; ſometimes yellow or brown.

A ſpecimen of the firſt variety from Dalecarlia, analyſed by Bergman, contained
63.9 ſilica,
16.0 carbonat of lime,
12.8 carbonat of magneſia,
6.0 oxide of iron,
1.1 alumina.

99.8 *

* Opuſc. iv. 170.

A ſpecimen of the ſecond variety yielded to the ſame chemiſt 64.0 ſilica,
17.2 carbonat of magneſia,
13.9 carbonat of lime,
2.7 alumina,
2.2 oxide of iron.

100.0 ‡

‡ Ibid. p. 163.

A ſpecimen of the third variety contained, according to the ſame analyſis, 56.2 ſilica,
26.1 carbonat of magneſia,
12.7 carbonat of lime,
3.0 iron,
2.0 alumina.

100.0 §

Twelve

§ Ibid. p. 170.

(h) *Kirw.* I. 171.—*Bartolin, De Lapide Nephritico.*—*Lehman, Nov. Comm. Petropol.* X. 381.—*Hoepfner, Hiſt. Nat. de la Suiſſe*, I. 251.

(i) *Kirw.* I. 159.—*Bergman*, IV. 160—*Plot, Phil. Tranſ.* XV. 1051.—*Nebel, Jour. de Phyſ.* II. 62.—*Ibid.* III. 367.

Earths and Stones.

Twelve different specimens of asbestus, analysed by Bergman, yielded the same ingredients, differing a little in their proportions *.

* Opusc. iv. 175.

86 Asbestinite.

SPECIES 2. Asbestinite (K).

This stone is amorphous. Texture foliated or broad striated. Lustre silky, 3. Transparency 1 to 2. Hardness 5 to 6. Sp. gr. from 2.806 to 2.880. Colour white with shades of red, yellow, green or blue. At 150° Wedgewood it melts into a green glass.

87 G. XX. 1. SILM. Pyroxen.

GENUS XX. 1. SILM.

SPECIES 1. Pyroxen.

This stone is found abundantly in lava and other volcanic productions (L). It is always crystallized. The primitive form of its crystals is an oblique angled prism, whose bases are rhombs with angles of 92° 18', and 37° 42' †. It generally crystallizes in eight-sided prisms, terminated by dihedral summits ‡. Its texture is foliated. Hardness 9. Colour black; sometimes green. Powder greenish grey §. Commonly attracted by the magnet *. Scarcely fusible by the blow pipe †. With borax it melts into a yellowish glass, which appears red while it is hot ‡.

† Hauy, Jour. de Min. N° xxviii. 269.
‡ De Lisle, ii. 398.
§ Vauquelin.
* Ferber.
† Le Lievre.
‡ Vauquelin.

According to the analysis of Vauquelin, it is composed of

52.00	silica,
14.66	oxide of iron,
13.20	lime,
10.00	magnesia,
3.33	alumina,
2.00	oxide of manganese.
95.19 §	

§ Jour de Min. N° xxxix. 172.

88 Asbestoid.

SPECIES 2. Asbestoid *.

This stone has obtained its name from its similarity to common asbestus. It is amorphous. Its texture is foliated or striated. Its lustre common or glassy, from 2 to 3. Transparency from 0 to 1. Hardness 6 to 7. Sp. gr. from 3 to 3.31. Colour olive or leek green; when decomposing, brown. Before the blowpipe it melts *per se* into a brown globule. With borax it forms a violet-coloured globule verging towards hyacinth *. According to the analysis of Mr Macquart, it is composed of

* Kirwan, i. 166.

* Macquart, Ann. de Chim. xxii. 83.

46	silica,
20	oxide of iron,
11	lime,
10	oxide of manganese,
8	magnesia.
95 †	

† Ibid.

There is a variety of this species which Kirwan calls metalliform asbestoid. Its lustre is semimetallic, 3. Opaque. Hardness 8 to 9. Sp. gr. 3.356. Colour grey, sometimes inclining to red ‡.

‡ Kirwan's Min. i. 167.

Simple Stones.

GENUS XX. 2. SMIL.

89 G. XX. 2. SMIL. Shorlaceous actinolite.

SPECIES 3. Shorlaceous actinolite (M).

This stone crystallizes in four or six sided prisms, thicker at one end than the other; hence it has been called by the Germans *strahlstein*, "arrow-stone." The crystals sometimes adhere longitudinally. Fracture hackly. External lustre glassy, 3 to 4; internal, 1 to 2. Transparency from 2 to 3; sometimes 1. Hardness from 7 to 10. Sp. gr. 3.023 to 3.45. Colour leek or dark green.

This stone is often the matrix of iron, copper, and tin ores.

90 Lamellar actinolite.

SPECIES 5. Lamellar actinolite.

This stone resembles hornblende. It is amorphous. Texture foliated. Lustre various in different places. Transparency 0, or scarce 1. Sp. gr. 2.916. Colour dark yellowish or greenish grey.

91 Glassy actinolite.

SPECIES 6. Glassy actinolite.

This stone is found amorphous, composed of fibres adhering longitudinally, or in slender four or six sided prisms. Texture fibrous. Fragments long splintery, so sharp that they can scarcely be handled without injury. External lustre glassy or silky, 3 to 4; internal 0. Transparency 2. Exceedingly brittle. Sp. gr. 2.95 to 2.493. Colour leek green; sometimes verging towards greenish or silver white; sometimes stained with yellowish or brownish red. According to Bergman it is composed of

72.0	silica,
12.7	carbonat of magnesia,
6.0	carbonat of lime,
7.0	oxide of iron,
2.0	alumina.
99.7 §	

§ Opusc. iv. 171.

92 G. XXI. SL. Shistose hornstone.

GENUS XXI. SL.

SPECIES 1. Shistose hornstone *.

* Kirwan, i. 305.

The structure of this stone is slaty. Lustre from 0 to 1. Commonly opaque. Hardness 9 to 10. Sp. gr. from 2.596 to 2.641. Colour dark bluish or blackish grey. Infusible *per se*.

Variety 1. Siliceous shistus.

Commonly intersected by reddish veins of iron stone. Fracture splintery. Lustre 0. Transparency from 0 to 1.

Variety 2. Basanite or Lydian stone.

Commonly intersected by veins of quartz. Fracture even; sometimes inclining to conchoidal. Lustre scarce 1. Hardness 10. Sp. gr. 2.596. Powder black. Colour greyish black.

This, or a stone similar to it, was used by the ancients as a touchstone. They drew the metal to be examined along the stone, and judged of its purity by the

(K) *Kirw. Min.* I. 165. Is this the *tremolite* of Werner? It certainly is not the *tremolite* of the French mineralogists.

(L) Hence the name *pyroxen* given it by Hauy; from πυρ *fire*, and ξενος, *a stranger*. It means, as he himself explains it, *a stranger in the regions of fire*. By this he means to indicate, that pyroxen, though present in lava, is not a volcanic production.

(M) In this and the following species we have followed Mr. Kirwan's new arrangement exactly, without even venturing to give the synonimes of other authors. The descriptions which have been given are so many and incomplete, and the minerals themselves are still so imperfectly known, and have got so many names, that no part of mineralogy is in a state of greater confusion.

Earths and Stones. the colour of the metallic ſtreak. On this account they called it βασανος, *the trier*. They called it alſo *Lydian ſtone*, becauſe, as Theophraſtus informs us, it was found moſt abundantly in the river Tmolus in Lydia *. A ſpecimen of the firſt variety, analyſed by Wiegleb, contained

* *Hill's Theophraſtus, περι λιθων*, p. 190.

75.0 ſilica,
10.0 lime,
4.6 magneſia,
3.5 iron,
5.2 carbon.
———
98.3

This ſpecies is rather a mechanical mixture than a chemical combination.

93 G. XXII. zs. Zircon.

GENUS XXII. ZS.

SPECIES I. Zircon †.

Jargon—Hyacinth.

† *Kirwan*, i. 257. and 333.

This ſtone is brought from Ceylon, and found alſo in France, Spain, and other parts of Europe. It is commonly cryſtallized. The primitive form of its cryſtals is an octahedron ‡, compoſed of two four-ſided pyramids applied baſe to baſe, whoſe ſides are iſoſceles triangles (N). The inclination of the ſides of the ſame pyramid to each other is 124° 12′; the inclination of the ſides of one pyramid to thoſe of another 82° 50′. The ſolid angle at the apex is 73° 44′ §. The varieties of the cryſtalline forms of zircon amount to ſeven. In ſome caſes there is a four-ſided priſm interpoſed between the pyramids of the primitive form; ſometimes all the angles of this priſm are wanting, and two ſmall triangular faces in place of each; ſometimes the cryſtals are dodecahedrons, compoſed of a flat four-ſided priſm with hexagonal faces, terminated by four-ſided ſummits with rhomboidal faces ‖; ſometimes the edges of this priſm, ſometimes the edges where the priſm and ſummit join, and ſometimes both together, are wanting, and we find ſmall faces in their place. For an accurate deſcription and figure of theſe varieties, we refer to *Mr Hauy* ¶.

‡ Fig. 25.

§ *Hauy, Jour. de Min.* N° xxvi. 91.

‖ Fig. 26.

¶ *Ibid.*

The texture of the zircon is foliated. Internal luſtre 3. Tranſparency from 4 to 2. Cauſes a very great double refraction. Hardneſs from 10 to 16. Sp. gr. from 4.2 to 4.165 *. Colour commonly reddiſh or yellowiſh; ſometimes it is limpid.

* *Ibid.*

Before the blow-pipe it loſes its colour, but not its tranſparency. With borax it melts into a tranſparent glaſs. Infuſible with fixed alkali and microcoſmic ſalt.

1. The variety formerly called *hyacinth* is of a yellowiſh red colour, mixed with brown. Its ſurface is ſmooth. Its luſtre 3. Its tranſparency 3 to 4.

2 The variety formerly called *jargon of Ceylon*, is either grey, greeniſh, yellowiſh brown, reddiſh brown, or violet. It has little external luſtre. Is ſometimes nearly opaque.

The firſt variety, according to the analyſis of Vauquelin, is compoſed of 64.5 zirconia,
32.0 ſilica,
2.0 oxide of iron.
———
98.5 †

† *Ibid.* p. 106.

A ſpecimen analyſed by Klaproth contained Saline Stones.
70.0 zirconia,
25.0 ſilica,
0.5 oxide of iron.
———
95.5 *

* *Beiträge*, i. 231.

The ſecond variety, according to Klaproth, who diſcovered the component parts of both theſe ſtones, contains
60.0 zirconia,
31.5 ſilica,
0.5 nickel and iron.
———
100.0 ‡

‡ *Ibid.* i. 219.

ORDER II. SALINE STONES.

94 Genera.

UNDER this order we comprehend all the minerals which conſiſt of an earthy baſis combined with an acid. They naturally divide themſelves into five genera. We ſhall deſcribe them in the following order.

I. CALCAREOUS SALTS.
Carbonat of lime,
Sulphat of lime,
Phoſphat of lime,
Fluat of lime,
Borat of lime.

II. BARYTIC SALTS.
Carbonat of barytes,
Sulphat of barytes.

III. STRONTITIC SALTS.
Carbonat of ſtrontites,
Sulphat of ſtrontites.

IV. MAGNESIAN SALTS.
Sulphat of magneſia.

V. ALUMINOUS SALTS.
Alum.

GENUS I. CALCAREOUS SALTS.

95 G. I. Calcareous ſalts.

This genus comprehends all the combinations of lime and acids which form a part of the mineral kingdom.

SPECIES I. Carbonat of lime.

96 Carbonat of lime.

No other mineral can be compared with carbonat of lime in the abundance with which it is ſcattered over the earth. Many mountains conſiſt of it entirely, and hardly a country is to be found on the face of the globe where, under the names of limeſtone, chalk, marble, ſpar, it does not conſtitute a greater or ſmaller part of the mineral riches.

It is often amorphous, often ſtalactitical, and often cryſtallized. The primitive form of its cryſtals is a parallelopiped, whoſe ſides are rhombs, with angles of 77° 30′ and 102° 30′ ‡. Its integrant molecules have the ſame form. The varieties of its cryſtals amount to more than 40; for a deſcription and figure of which we refer to *Romé de Liſle* * and *Hauy* (O).

‡ Fig. 28.

* *Cryſtal.* i. 497.

When cryſtallized, its texture is foliated; when amorphous, its ſtructure is ſometimes foliated, ſometimes ſtriated, ſometimes granular, and ſometimes earthy. Its luſtre

(N) Let ABC (fig. 27.) be one of the ſides. Draw the perpendicular BD; then $AB = 5$, $BD = 4$, $AD = 3$.

(O) *Eſſai d'une Theorie*, &c. p. 75.—*Jour. de Phyſ.* 1793, Auguſt, p. 114.—*Jour. d'Hiſt. Nat.* 1792, February, p. 148.—*Ann. de Chim.* XVII. 249. &c.—*Jour. de Min.* N° XXVIII. 304.

luſtre varies from o to 3. Tranſparency from o to 4. It cauſes double refraction; and it is the only mineral which cauſes double refraction through two parallel faces of the cryſtal. Hardneſs from 3 to 9. Sp. gr. from 2.315 to 2.78. Colour, when pure, white. Effervesces violently with muriatic acid, and diſſolves completely, or leaves but a ſmall reſiduum. The ſolution is colourleſs.

This ſpecies occurs in a great variety of forms; and therefore has been ſubdivided into numerous varieties. All theſe may be conveniently arranged under two general diviſions.

I. Soft carbonat of lime.

Variety 1. Agaric mineral.

Mountain milk, or *mountain meal* of the Germans.

This variety is found in the clefts of rocks, or the bottom of lakes. It is nearly in the ſtate of powder; of a white colour, ſometimes with a ſhade of yellow; and ſo light that it almoſt floats on water.

Variety 2. Chalk.

The colour of chalk is white, ſometimes with a ſhade of yellow. Luſtre o. Opaque. Hardneſs 3 to 4. Sp. gr. from 2.315 to 2.657. Texture earthy. Adheres ſlightly to the tongue. Feels dry. Stains the fingers, and marks. Falls to powder in water. It generally contains about $\frac{2}{100}$ of alumina, and $\frac{3}{100}$ of water; the reſt is carbonat of lime.

Variety 3. Arenaceous limeſtone.

Colour yellowiſh white. Luſtre 1. Tranſparency 1. So brittle that ſmall pieces crumble to powder between the fingers. Sp. gr. 2.742. Phoſphoreſces in the dark when ſcraped with a knife, but not when heated. It conſiſts almoſt entirely of pure carbonat of lime.

Variety 4. Teſtaceous tufa.

The colour of this variety is yellowiſh or greyiſh white. It is exceedingly porous and brittle; and is either compoſed of broken ſhells, or reſembles mortar containing ſhells; or it conſiſts of fiſtulous concretions variouſly ramified, and reſembling moſs.

II. Indurated carbonat of lime.

Variety 1. Compact limeſtone.

The texture of this variety is compact. It has little luſtre; and is moſt commonly opaque. Hardneſs 5 to 8. Sp. gr. 1.3864 to 2.72. Colour grey, with various ſhades of other colours. It moſt commonly contains about $\frac{1}{10}$th of alumina, oxide of iron, &c.; the reſt is carbonat of lime. This variety is uſually burnt as lime.

Variety 2. Granularly foliated limeſtone.

Structure ſometimes ſlaty. Texture foliated and granular. Luſtre 2 to 1. Tranſparency 2 to 1. Hardneſs 7 to 8. Sp. gr. 2.71 to 2.8376. Colour white, of various ſhades from other colours.

Variety 3. Sparry limeſtone.

Structure ſparry. Texture foliated. Fragments rhomboidal. Luſtre 2 to 3. Tranſparency from 2 to 4; ſometimes 1. Hardneſs 5 to 6. Sp. gr. from 2.693 to 2.718. Colour white; often with various ſhades of other colours. To this variety belong all the cryſtals of carbonat of lime.

Variety 4. Striated limeſtone.

Texture ſtriated or fibrous. Luſtre 1 to o. Tranſparency 2 to 1. Hardneſs 5 to 7. Sp. gr. commonly from 2.6 to 2.77. Colours various.

Variety 5. Swine ſtone.

Texture often earthy. Fracture often ſplintery. Luſtre 1 to o. Tranſparency o to 1. Hardneſs 6 to 7. Sp. gr. 2.701 to 2.7121. Colour dark grey, of various ſhades. When ſcraped or pounded it emits an urinous or garlic ſmell.

Variety 6. Oviform.

This variety conſiſts of a number of ſmall round bodies, cloſely compacted together. Luſtre o. Tranſparency o or 1. Hardneſs 6 to 7.

97 Sulphat of lime.

SPECIES 2. Sulphat of lime.

Gypſum — Selenite.

This mineral is found abundantly in Germany, France, England, Italy, &c.

It is found ſometimes in amorphous maſſes, ſometimes in powder, and ſometimes cryſtallized. The primitive form of its cryſtals, according to Romé de Liſle, is a decahedron *, which may be conceived as two four-ſided pyramids applied baſe to baſe, and which, inſtead of terminating in pointed ſummits, are truncated near their baſes; ſo that the ſides of the pyramids are trapeziums, and they terminate each in a rhomb. Theſe rhombs are the largeſt faces of the cryſtal. The angles of the rhombs are 52° and 158°. The inclination of two oppoſite faces of one pyramid to the two ſimilar faces of the other pyramid is 145°, that of the other faces 110°†. Sometimes ſome of the faces are elongated; ſometimes it cryſtallizes in ſix-ſided priſms, terminated by three or four-ſided ſummits, or by an indeterminate number of curvilinear faces. For a deſcription and figure of theſe varieties, we refer to *Romé de Liſle* ‡.

* Fig. 29.

† *Cryſtal.* i. 144.

‡ *Ibid.*

The texture of ſulphat of lime is moſt commonly foliated. Luſtre from o to 4. Tranſparency from o to 4. It cauſes double refraction. Its hardneſs does not exceed 4. Its ſp. gr. from 1.872 to 2.311. Colour commonly white or grey.

Before the blow-pipe, it melts into a white enamel, provided the blue flame be made to play upon the edges of its laminæ. When the flame is directed againſt its faces, the mineral falls into powder §.

It does not efferveſce with muriatic acid, except it be impure; and it does not diſſolve in it.

§ *Le Lievre, Jour. de Min.* No xxviii. 315.

The following varieties of this mineral are deſerving of attention.

Variety 1. Broad foliated ſulphat.

Texture broad foliated. Luſtre glaſſy, from 4 to 2. Tranſparency from 4 to 3. Hardneſs 4. Sp. gr. 2.311. Colour grey, often with a ſhade of yellow.

Variety 2. Grano-foliated ſulphat.

Texture foliated, and at the ſame time granular; ſo that it eaſily crumbles into powder. Luſtre 2 to 3. Tranſparency 2 to 3. Hardneſs 4 to 3. Sp. gr. from 2.274 to 2.310. Feels ſoft. Colour white or grey, often with a tinge of yellow, blue, or green; ſometimes fleſh red, brown, or olive green.

Variety 3. Fibrous ſulphat.

Texture fibrous. Fragments long ſplintery. Luſtre 2 to 3. Tranſparency 2 to 1; ſometimes 3. Hardneſs 4. Brittle. Sp. gr. 2.300. Colour white, often with a ſhade of grey, yellow, or red; ſometimes fleſh red, and ſometimes honey yellow; ſometimes ſeveral of theſe colours meet in ſtripes.

Variety 4. Compact ſulphur.

Texture compact. Luſtre 1 or o. Tranſparency 2 to 1,

Earths and Stones.

1, ſometimes 0. Hardneſs 4. Sp. gr. from 1.872 to 2.288. Feels dry, but not harſh. Colour white, with a ſhade of grey, yellow, blue, or green; ſometimes yellow; ſometimes red; ſometimes ſpotted, ſtriped, or veined.

Variety 5. Farinaceous ſulphat.

Of the conſiſtence of meal. Luſtre 0. Opaque. Scarcely ſinks in water. Is not gritty between the teeth. Feels dry and meagre. Colour white. When heated below redneſs, it becomes of a dazzling white.

98 Phoſpat of lime.

SPECIES 3. Phoſphat of lime.

Apatite—Phoſphorite—Chryſolite—of the French.

This ſubſtance is found in Spain, where it forms whole mountains, and in different parts of Germany. It is ſometimes amorphous, and ſometimes cryſtallized. The primitive form of its cryſtals is a regular ſix-ſided priſm *. Its integrant molecule is a regular triangular priſm, whoſe height is to a ſide of its baſe as 1 to $\sqrt{2}$ †. Sometimes the edges of the primitive hexagonal priſm are wanting, and ſmall faces in their place; ſometimes there are ſmall faces inſtead of the edges which terminate the priſm; ſometimes theſe two varieties are united; ſometimes the terminating edges and the angles of the priſm are replaced by ſmall faces ‡; and ſometimes the priſm is terminated by four ſided pyramids §.

* Fig. 30.

† *Hauy, Jour. de Min.* N° xxviii. p. 310.

‡ Fig. 31.

§ *Hauy, ibid.*

Its texture is foliated. Its fracture uneven, tending to conchoidal. External luſtre from 2 to 3, internal 3 to 2. Tranſparency from 4 to 2. Cauſes ſingle refraction. Hardneſs 6 to 7. Brittle. Sp. gr. from 2.8249 to 3.218. Colour commonly green or grey; ſometimes brown, red, blue, and even purple.

It is infuſible by the blow-pipe. When its powder is thrown upon burning coals, it emits a yellowiſh green phoſphoreſcent light. It is ſoluble in muriatic acid without efferveſcence or decompoſition, and the ſolution often bomes gelatinous.

99 Fluat of lime.

SPECIES 4. Fluat of lime.

Fluor.

This mineral is found abundantly in different countries, particularly in Derbyſhire. It is both amorphous and cryſtallized.

The primitive form of its cryſtals is the regular octohedron; that of its integrant molecules the regular tetrahedron ‖. The varieties of its cryſtals hitherto obſerved amount to 7. Theſe are the primitive octohedron; the cube; the rhomboidal dodecahedron; the cubo octohedron ¶, which has both the faces of the cube and of the octohedron; the octohedron wanting the edges; the cube wanting the edges, and either one face *, or two faces in place of each. For a deſcription and figure of theſe we refer to *Mr Hauy* †.

‖ *Hauy, ibid.* p. 325.

¶ Fig. 32.

* Fig. 33.

† *Ibid.*

The texture of fluat of lime is foliated. Luſtre from 2 to 3, ſometimes 0. Tranſparency from 2 to 4, ſometimes 1. Cauſes ſingle refraction. Hardneſs 8. Very brittle. Sp. gr. from 3.0943 to 3.1911. Colours numerous, red, violet, green, red, yellow, blackiſh purple. Its powder thrown upon hot coals emits a bluiſh or greeniſh light. Two pieces of it rubbed in the dark phoſphoreſce. It decrepitates when heated. Before the blow-pipe it melts into a tranſparent glaſs. §

§ *Ibid.*

It admits of a poliſh, and is often formed into vaſes and other ornaments.

100 Borat of lime.

SPECIES 5. Borat of lime.

Boracite.

This mineral has been found at Ka lkberg near Luneburg, ſeated in a bed of ſulphat of lime. It is cryſtallized. The primitive form of its cryſtals is the cube *. In general, all the edges and angles of the cube are truncated; ſometimes, however, only the alternate angles are truncated †. The ſize of the cryſtals does not exceed half an inch.

Saline Stones.

* *Hauy, Jour. de Min.* N° xxvii. p. 325.

† *Hauy*, and *Weſtrum.*

The texture of this mineral is compact. Its fracture is flat conchoidal. External luſte 3; internal, greaſy, 2. Tranſparency from 2 to 3. Hardneſs 9 to 10. Sp. gr. 2.566. Colour greyiſh white, ſometimes paſſing into greeniſh white or purpliſh.

When heated it becomes electric; and the angles of the cube are alternately poſitive and negative ‡.

Before the blow-pipe it froths, emits a greeniſh light, and is converted into a yellowiſh enamel, garniſhed with ſmall points, which, if the heat be continued, dart out in ſparks §.

‡ *Hauy, ibid.* and *Ann. de Chim.* ix. 59.

§ *Le Lievre, Jour. de Min. ibid.*

According to Weſtrum, who diſcovered its component parts, it contains

68	boracic acid,
13.5	magneſia,
11	lime,
1	alumina,
2	ſilica,
1	iron.
96 ¶	

¶ *Ann. de Chim.* ii. 116.

SPECIES 6. Nitrat of lime.

Found abundantly mixed with native nitre. For a deſcription ſee the article CHEMISTRY in this *Supplement*, n° 672. 101 Nitrat of lime.

102 G. II. Barytic ſalts.

GENUS II. BARYTIC SALTS.

This genus comprehends the combinations of barytes with acids.

103 Carbonat of barytes.

SPECIES 1. Carbonat of barytes.

Witherite.

This mineral was diſcovered by Dr Withering; hence Werner has given it the name of *witherite*. It is found both amorphous and cryſtallized. The cryſtals are octohedrons or dodecahedrons, conſiſting of four or ſix ſided pyramids applied baſe to baſe; ſometimes the ſix-ſided pyramids are ſeparated by a priſm; ſometimes ſeveral of theſe priſms are joined together in the form of a ſtar.

Its texture is fibrous. Its fracture conchoidal. Its fragments long ſplintery. Luſtre 2. Tranſparency 2 to 3. Hardneſs 5 to 6. Brittle. Sp. gr. 4.3 to 4.338. Colour greeniſh white. When heated it becomes opaque. Its powder phoſphoreſces when thrown on burning coals *.

* *Hauy.*

It is ſoluble with efferveſcence in muriatic acid. The ſolution is colourleſs.

According to Pelletier it contains

62	barytes,
22	carbonic acid,
16	water.
100 †	

† *Jour. de Min.* N° xxi. p. 46.

104 Sulphat of barytes.

SPECIES 2. Sulphat of barytes.

Boroſelenite.

This mineral is found abundantly in many countries, particularly in Britain. It is ſometimes in powder, often in amorphous maſſes, and often cryſtallized. The primitive form of its cryſtals is a rectangular priſm, whoſe

Earths and Stones.

whoſe baſes are rhombs, with angles of 101° 30′ and 78° 30′ *. The varieties of its cryſtals are very numerous. For a deſcription and figure of them we refer to *Romé de Liſle* † and *Hauy* ‡. The moſt common varieties are the octohedron with cuneiform ſummits, the ſix or four ſided priſm, the hexangular table with bevelled edges. Sometimes theſe cryſtals are needle form.

Its texture is commonly foliated. Luſtre from 0 to 2. Tranſparency from 2 to 0; in ſome caſes 3 or 4. Hardneſs from 5 to 6. Sp. gr. from 4.4 to 4.44. Colour commonly white, with a ſhade of yellow, red, blue, or brown.

When heated it decrepitates. It is fuſible *per ſe* by the blue flame of the blow-pipe, and is converted into ſulphurat of barytes. Soluble in no acid except the ſulphuric; and precipitated from it by water.

Variety 1. Foliated ſulphat.

Luſtre 3 to 3. Tranſparency from 4 to 2, ſometimes 1. Colours white, reddiſh, bluiſh, yellowiſh, blackiſh, greeniſh. Mr Werner ſubdivides this variety into three, according to the nature of the texture. Theſe three ſubdiviſions are *granularly foliated*, *ſtraight foliated*, *curve foliated*.

Variety 2. Fibrous ſulphat.

Texture fibrous; fibres converging to a common centre. Luſtre ſilky or waxy, 2. Tranſparency 2 to 1. Hardneſs 5. Colours yellowiſh, bluiſh, reddiſh.

Variety 3. Compact ſulphat.

Texture compact. Luſtre 0 to 1. Tranſparency 1 to 0. Feels meagre. Almoſt conſtantly impure. Colours light yellow, red, or blue.

Variety 4. Earthy ſulphat.

In the form of coarſe duſty particles, ſlightly cohering. Colour reddiſh or yellowiſh white.

* *Hauy, Eſſai d'une Theorie,* &c. p. 119.
† *Cryſtal.* i. 588.
‡ *Ibid.* and *Ann. de Chim.* xii. 3.

Genus III. Strontitic Salts.

105 G. III. Strontitic ſalts.

This genus comprehends all the combinations of ſtrontites and acids which form a part of the mineral kingdom.

Species 1. Carbonat of ſtrontites

106 Carbonat of ſtrontites.

This mineral was firſt diſcovered in the lead mine of Srontion in Argyleſhire; and ſince that time it is ſaid to have been diſcovered, though not in great abundance, in other countries. It is found amorphous, and alſo cryſtallized in needles, which, according to Hauy, are regular ſix-ſided priſms.

Its texture is fibrous; the fibres converge. Fracture uneven. Luſtre 2. Tranſparency 2. Hardneſs 5. Sp. gr. from 3.4 to 3.66. Colour light green. Does not decrepitate when heated. Before the blow-pipe becomes opaque and white, but does not melt. With borax it effervesces, and melts into a tranſparent colourleſs glaſs. Effervesces with muriatic acid, and is totally diſſolved. The ſolution tinges flame purple.

Species 2. Sulphat of ſtrontites.

Celeſtine.

107 Sulphat of ſtrontites.

This mineral has been found in Pennſylvania, in Germany, in France, in Sicily, and Britain. It was firſt diſcovered near Briſtol by Mr Clayfield. There it is found in ſuch abundance, that it has been employed in mending the roads.

It occurs both amorphous and cryſtallized. The cryſtals are moſt commonly bevelled tables, ſometimes rhomboidal cubes. Its texture is foliated. More or leſs tranſparent. Hardneſs 5. Sp. gr. from 3.51 to 3.96. Colour moſt commonly a fine ſky blue; ſometimes reddiſh; ſometimes white, or nearly colourleſs §.

Aggregates

Klaproth found a ſpecimen of this mineral from Pennſylvania compoſed of 58 ſtrontites,
42 ſulphuric acid.

100 ||.

According to the analyſis of Mr Clayfield, the ſulphat ſtrontites found near Briſtol is compoſed of
58.25 ſtrontites,
41.75 ſulphuric acid of 2.24, and a little iron ¶.

100.00

According to the analyſis of Vauquelin, the ſulphat of ſtrontites found at Bouvron in France, which was contaminated with .1 of carbonat of lime, is compoſed of
54 ſtrontites,
45 ſulphuric acid.

99 *

§ *Clayfield, Nicholſon's Jour.* iii. 36.
|| *Beiträge,* ii. 97.
¶ *Ibid. Nicholſon's Journal.*
* *Jour. de Min.* N° xxxvii. 6.

Genus IV. Magnesian Salts.

108 G. IV. Magneſian Salts.

This genus comprehends the combinations of magneſia and acids which occur in the mineral kingdom. Only two ſpecies have hitherto been found; namely,

Species 1. Sulphat of magneſia.

109 Sulphat of magneſia.

It is found in Spain, Bohemia, Britain, &c.; and enters into the compoſition of many mineral waters.

For a deſcription of it, we refer to Chemistry, n° 633. in this *Suppl.*

Species 2. Nitrat of magneſia.

110 Nitrat of magneſia.

Found ſometimes aſſociated with nitre. For a deſcription ſee Chemistry, n° 674,

Genus V. Aluminous Salts.

111 G. V. Aluminous ſalts.

This genus comprehends thoſe combinations of alumina and acids which occur in the mineral kingdom.

Species 1. Alum.

112 Alum.

This ſalt is found in cryſtals, in ſoft maſſes, in flakes, and inviſibly mixed with the ſoil. For a deſcription, we refer to Chemistry, n° 636.

Order III. AGGREGATES.

This order comprehends all mechanical mixtures of earths and ſtones found in the mineral kingdom. Theſe are exceedingly numerous: the mountains and hills, the mould on which vegetables grow, and indeed the greater part of the globe, may be conſidered as compoſed of them. A complete deſcription of aggregates belongs rather to geology than mineralogy. It would be improper, therefore, to treat of them fully here. But they cannot be altogether omitted; becauſe aggregates are the firſt ſubſtances which preſent themſelves to the view of the practical mineralogiſt, and becauſe, without being acquainted with the names and component parts of many of them, the moſt valuable mineralogical works could not be underſtood.

113 Diviſion of aggregates.

Aggregates may be comprehended under four diviſions: 1. Mixtures of earths; 2. Amorphous fragments of ſtones agglutinated together; 3. Cryſtallized ſtones, either agglutinated together or with amorphous ſtones; 4. Aggregates formed by fire. It will be exceedingly convenient

Earths and Stones. convenient to treat each of theſe ſeparately. We ſhall therefore divide this order into four ſections.

Sect. I. *Aggregates of Earths.*

The moſt common earthy aggregates may be comprehended under the following genera:

1. Clay,
2. Colorific earths,
3. Marl,
4. Mould.

114 Clay.

Genus I. Clay.

Clay is a mixture of alumina and ſilica in various proportions. The alumina is in a ſtate of an impalpable powder; but the ſilica is almoſt always in ſmall ſtones, large enough to be diſtinguiſhed by the eye. Clay, therefore, exhibits the character of alumina, and not of ſilica, even when this laſt ingredient predominates. The particles of ſilica are already combined with each other; and they have ſo ſtrong an affinity for each other that few bodies can ſeparate them; whereas the alumina, not being combined, readily diſplays the characters which diſtinguiſh it from other bodies. Beſides alumina and ſilica, clay often contains carbonat of lime, of magneſia, barytes, oxide of iron, &c. And as clay is merely a mechanical mixture, the proportion of its ingredients is exceedingly various.

Clay has been divided into the following ſpecies:

115 Porcelain clay.

Species 1. Porcelain clay.

Its texture is earthy. Its luſtre 0. Opaque. Hardneſs 4. Sp. gr. from 2.23 to 2.4. Colour white, ſometimes with a ſhade of yellow or red. Adheres ſlightly to the tongue. Feels ſoft. Falls to powder in water.

A ſpecimen, analyſed by Haſſenfratz, contained

62 ſilica,
19 alumina,
12 magneſia,
7 ſulphat of barytes.

100 *

A ſpecimen, analyſed by Mr Wedgewood, contained

60 alumina,
20 ſilica,
12 air of water.

92

* Ann. de Chim. xiv. 144.

116 Common clay.

Species 2. Common clay.

Its texture is earthy. Luſtre 0. Opaque. Hardneſs 3 to 6. Sp. gr. 1.8 to 2.68. Adheres ſlightly to the tongue. Often feels greaſy. Falls to powder in water. Colour, when pure, white; often tinged blue or yellow.

Variety 1. Potter's clay.

Hardneſs 3 to 4. Sp. gr. 1.8 to 2. Stains the fingers ſlightly. Acquires ſome poliſh by friction. Colour white; often with a tinge of yellow or blue; ſometimes browniſh, greeniſh, reddiſh. Totally diffuſible in water; and, when duly moiſtened, very ductile.

Variety 2. Indurated clay.

Hardneſs 5 to 6. Does not diffuſe itſelf in water, but falls to powder. Diſcovers but little ductility. Colours grey, yellowiſh, bluiſh, greeniſh, reddiſh, browniſh.

Aggregates

Variety 3. Shiſtoſe clay.

Structure ſlaty. Sp. gr. from 2.6 to 2.68. Feels ſmooth. Streak white or grey. Colour commonly bluiſh, or yellowiſh grey; ſometimes blackiſh, reddiſh, greeniſh. Found in ſtrata, uſually in coal mines.

This variety is ſometimes impregnated with bitumen. It is then called bituminous *ſhale*.

117 Lithomarga.

Species 3. Lithomarga.

Texture earthy. Fracture conchoidal. Luſtre from 0 to 2. Opaque. Hardneſs 3 to 7. Sp. gr. when pretty hard, 2.815. Surface ſmooth, and feels ſoapy, Adheres ſtrongly to the tongue. Falls to pieces, and then to powder, in water; but does not diffuſe itſelf through that liquid. Fuſible *per ſe* into a frothy maſs.

Variety 1. Friable lithomarga.

Formed of ſcaly particles ſlightly cohering. Luſtre 1 to 0. Hardneſs 3 to 4. Exceedingly light. Feels very ſmooth, and aſſumes a poliſh from the nail. Colour white; ſometimes tinged yellow or red.

Variety 2. Indurated lithomarga.

Hardneſs 4 to 7. The ſofter ſorts adhere very ſtrongly to the tongue when newly broken; the harder very moderately. Colours grey, yellow, red, brown, blue.

A ſpecimen of lithomarga from Oſmund, analyſed by Bergman, contained

60.0 ſilica,
11.0 alumina,
5.7 carbonat of lime,
4.7 oxide of iron,
0.5 carbonat of magneſia,
18.0 water and air.

99.9 *

* Opuſc. iv.

118 Bole.

Species 4. Bole.

Texture earthy. Fracture conchoidal. Luſtre 0. Tranſparency ſcarce 1. Hardneſs 4. Sp. gr. from 1.4 to 2. Acquires a poliſh by friction. Scarcely adheres to the tongue. Feels greaſy. Colour yellow or brown; ſometimes red; ſometimes ſpotted.

The lemnian earth which belongs to this ſpecies, according to the analyſis of Bergman, contains

47,0 ſilica,
19,0 alumina,
6.0 carbonat of magneſia,
5.4 carbonat of lime,
5.4 oxide of iron,
17.0 water and air.

99.8 †

† Ibid. p. 157.

119 Fullers earth.

Species 5. Fullers earth.

Texture earthy. Structure ſometimes ſlaty. Fracture imperfectly conchoidal. Luſtre 0. Opaque. Hardneſs 4. Receives a poliſh from friction. Does not adhere to the tongue. Feels greaſy. Colour uſually light green.

A ſpecimen from Hampſhire, analyſed by Bergman, contained

51.8 ſilica,
25.0 alumina,
3.3 carbonat of lime,
3.7 oxide of iron,
0.7 carbonat of magneſia.
15.5 moiſture.

100.0 ‡

‡ Ibid. 159.

This

This earth is uſed by fullers to take the greaſe out of their cloth before they apply ſoap. It is eſſential to fullers earth that the particles of ſilica be very fine, otherwiſe they would cut the cloth. Any clay, poſſeſſed of this laſt property, may be conſidered as *fullers earth*; for it is the alumina alone which acts upon the cloth, on account of its ſtrong affinity for greaſy ſubſtances.

120 G. II. Colorific earths.

Genus II. Colorific Earths.

The minerals belonging to this genus conſiſt of clay, mixed with ſo large a quantity of ſome colouring ingredient as to render them uſeful as paints. The colouring matter is commonly oxide of iron, and ſometimes charcoal.

121 Red chalk.

Species 1. Red chalk.
Reddle.

Texture earthy. Fracture conchoidal. Luſtre 0. Opaque. Hardneſs 4. Sp. gr. inconſiderable. Colour dark red.

Feels rough. Stains the fingers. Adheres to the tongue. Falls to powder in water. Does not become ductile. When heated it becomes black, and at 159° Wedgewood melts into a greeniſh yellow frothy enamel.

Compoſed of clay and oxide of iron.

122 Yellow chalk.

Species 2. Yellow chalk.

Texture earthy. Fracture conchoidal. Hardneſs 3. Sp. gr. inconſiderable. Colour ochre yellow.

Feels ſmooth or greaſy. Stains the fingers. Adheres to the tongue. Falls to pieces in water. When heated becomes red; and at 156° Wedgewood melts into a brown porous porcelain.

According to Sage, it contains

50 alumina,
40 oxide of iron,
10 water, with ſome ſulphuric acid.
———
100 *

* Mem. Par. 1779, 313.

123 Black chalk.

Species 3. Black chalk.

Structure ſlaty. Texture earthy. Fragments ſplintery. Luſtre 0. Opaque. Hardneſs 5. Sp. gr. 2.144 to 2.277. Colour black. Streak black.

Feels ſmooth. Adheres ſlightly to the tongue. Does not moulder in water. When heated to redneſs it becomes reddiſh grey.

According to Wiegleb, it is compoſed of

64.50 ſilica,
11.25 alumina,
11.00 charcoal,
2.75 oxide of iron,
7.50 water.
———
97.00 †

† Ann. de Chim. xxx. 13.

124 Green earth.

Species 4. Green earth.

Texture earthy. Luſtre 0. Opaque. Hardneſs 6 to 7. Sp. gr. 2.637. Colour green.

Commonly feels ſmooth. Does not ſtain the fingers. Often falls to powder in water. When heated it becomes reddiſh brown; and at 147° Wedgewood melts into a compact glaſs.

Compoſed of clay, oxides of iron, and nickel.

125 G. III. Marl.

Genus III. Marl.

A mixture of carbonat of lime and clay, in which the carbonat conſiderably exceeds the other ingredient, is called *marl*.

Its texture is earthy. Luſtre 0. Opaque. Hardneſs from 4 to 8; ſometimes in powder. Sp. gr. from 1.6 to 2.877. Colour uſually grey, often tinged with other colours. Effervеſces with acids.

Some marls crumble into powder when expoſed to the air; others retain their hardneſs for many years.

Marls may be divided into two ſpecies: 1. Thoſe which contain more ſilica than alumina; 2. Thoſe which contain more alumina than ſilica. Mr Kirwan has called the firſt of theſe *ſiliceous*, the ſecond *argillaceous*, marls. Attention ſhould be paid to this diſtinction when marls are uſed as a manure.

Genus IV. Mould. 126 G. IV. Mould.

By *mould* is meant the ſoil on which vegetables grow. It contains the following ingredients: ſilica, alumina, lime, magneſia (ſometimes), iron, carbon derived from decayed vegetable and animal ſubſtances, carbonic acid, and water. And the good or bad qualities of *ſoils* depends upon a proper mixture of theſe ingredients. The ſilica is ſeldom in the ſtate of an impalpable powder, but in grains of a greater or ſmaller ſize: Its chief uſe ſeems to be to keep the ſoil open and pervious to moiſture. If we paſs over the carbon, the iron, and the carbonic acid, the goodneſs of a ſoil depends upon its being able to retain the quantity of moiſture which is proper for the nouriſhment of vegetables, and no more. Now the retentive power of a ſoil increaſes with the proportion of its alumina, lime, or magneſia, and diminiſhes as the proportion of its ſilica increaſes. Hence it follows, that in a dry country, a fertile ſoil ſhould contain leſs ſilica, and more of the other earths, than in a wet country.

Giobert found a fertile ſoil near Turin, where it rains annually 30 inches, to contain

From 77 to 79 ſilica,
9 — 14 alumina,
5 — 12 lime.

Near Paris, where it rains about 20 inches annually, Mr Tillet found a fertile ſoil to contain

Coarſe ſand 25
Fine ſand 21
— 46.0 ſilica,
16.5 alumina,
37.5 lime.
———
100.0 *

* Kirwan on Manures.

The varieties of mould are too numerous to admit an accurate deſcription: we ſhall content ourſelves, therefore, with mentioning the moſt remarkable.

Species 1. Sand. 127 Sand.

This conſiſts of ſmall grains of ſiliceous ſtones not cohering together, nor ſoftened by water. When the grains are of a large ſize, the ſoil is called *gravel*.

Species 2. Clay. 128 Clay.

This conſiſts of common clay mixed with decayed vegetable and animal ſubſtances.

Species 3. Loam. 129 Loam.

Any ſoil which does not cohere ſo ſtrongly as clay, but more ſtrongly than chalk, is called *loam*. There are many varieties of it. The following are the moſt common.

Earths and Stones.

Variety 1. Clayey loam; called alfo *ftrong, ftiff, cold,* and *heavy*, loam.

It confifts of a mixture of clay and coarfe fand.

Variety 2. Chalky loam.

A mixture of clay, chalk, and coarfe fand; the chalk predominating.

Variety 3. Sandy loam.

A mixture of the fame ingredients; the fand amounting to .8 or .9 of the whole.

130 Till. SPECIES 4. Till.

Till is a mixture of clay and oxide of iron. It is of a red colour, very hard and heavy.

SECT II. *Aggregates of Amorphous Stones.*

THE aggregates which belong to this fection confift of amorphous fragments of ftones cemented together. They may be reduced to the following genera:

1. Sandftone,
2. Puddingftone,
3. Amygdaloid,
4. Breccia.

131 G. I. Sandftone. GENUS I. SANDSTONE.

Small grains of fand, confifting of quartz, flint, hornftone, filiceous fhiftus, or felfpar, and fometimes of mica, cemented together, are denominated fandftones. They feel rough and fandy; and, when not very hard, eafily crumble into fand. The cement or bafis by which the grains of fand are united to each other is of four kinds; namely, lime, alumina, filica, iron. Sandftones, therefore, may be divided into four fpecies.

132 Calcareous. SPECIES 1. Calcareous fandftones.

Calcareous fandftones are merely carbonat of lime or marl, with a quantity of fand interpofed between its particles. Though the quantity of fand, in many cafes, far exceeds the lime, calcareous fandftones are fometimes found cryftallized; and, in fome cafes, the cryftals, as might be expected, have fome of the forms which diftinguifh carbonat of lime. Thus the calcareous fandftone of Fountainbleau is cryftallized in rhomboidal tables. It contains, according to the analyfis of Laffone

62.5	filiceous fand,
37.5	carbonat of lime.
100	

Calcareous fandftones have commonly an earthy texture. Their furface is rough. Their hardnefs from 6 to 7. Their fpecific gravity about 2.5 or 2.6. Their colour grey; fometimes yellowifh or brown. They are fometimes burned for lime.

133 Aluminous. SPECIES 2. Aluminous fandftones.

The bafis of argillaceous fandftones is alumina, or rather clay. Their ftructure is often flaty. Their texture is compact, and either fine or coarfe grained, according to the fize of the fand of which they are chiefly compofed. Their hardnefs is from 6 to 8, or even 9. Their colour is ufually grey, yellow, or brown.

They are often formed into mill-ftones, filtering-ftones, and coarfe whet-ftones.

134 Siliceous. SPECIES 3. Siliceous fandftones.

Siliceous fandftones confift of grains of fand cemented together by filica, or fome fubftance which confifts chiefly of filica or flint. They are much harder than any of the other fpecies.

Sometimes ftones occur, confifting of grains of lime cemented together with filica. Thefe ftones are alfo denominated filiceous fandftones. Aggregates

SPECIES 4. Ferruginous fandftones. 135 Ferruginous.

The iron which acts as a cement in ferruginous fandftones is not far from a metallic ftate. When iron is completely oxidated, it lofes the property of acting as a cement. This is the reafon that ferruginous fandftones, when expofed to the air, almoft always crumble into powder.

The colour of ferruginous fandftones is ufually dark red, yellow, or brown. The grains of fand which compofe them are often pretty large. Their hardnefs is commonly inconfiderable.

GENUS II. PUDDING STONE. 136 G. II. Pudding ftone.

Pebbles of quartz, flint, or other fimilar ftones of a round or elliptical form, from the fize of rape feed to that of an egg, cemented together by a filiceous cement, often mixed with iron, have been denominated *pudding ftones*.

Pudding ftones, of courfe, are not inferior in hardnefs to quartz, flint, chalcedony, &c. of which the pebbles may confift. The colour of the cement is ufually yellow, brown, or red. Its fracture is conchoidal.

The finer forts of pudding ftones are capable of a fine polifh; the coarfe are ufed for mill-ftones.

GENUS III. AMYGDALOID. 137 G. III. Amygdaloid.

Rounded or elliptical maffes of chalcedony, zeolite, limeftone, lithomarga, fteatites, green earth, garnets, hornblende, or opal, cemented together by a bafis of indurated clay, trap, mullen, walken or kragg, conftitute an *amygdaloid.*

Amygdaloids are opaque. They have no luftre. Their fracture is uneven or conchoidal. Hardnefs 6 to 9. Their colours are as various as the ingredients of which they are compofed.

GENUS IV. BRECCIA. 138 G. IV. Breccia.

Angular fragments of the fame *fpecies* of ftone, agglutinated together, conftitute a *breccia.* This *calcareous* breccia confifts of fragments of marble cemented together by means of lime.

SECT. III. *Aggregates of Cryftals.*

THE minerals belonging to this fection confift either of cryftals of different kinds cemented together, or of cryftals and amorphous ftones cemented together.

They may be reduced under the following genera.

1. Granite,
2. Sienite,
3. Granatine,
4. Granitell,
5. Granilite,
6. Trap,
7. Porphyry.

GENUS I. GRANITE. 139 G. I. Granite.

An aggregate of felfpath, quartz, and mica, whatever be the fize or the figure of the ingredients, is denominated *granite.* This aggregate may be divided into two fpecies, namely, *common* granite, and *fhiftofe* granite or gneifs.

SPECIES 1. Common granite. 140 Common.

Its ftructure is always granular. The felfpar is often

amor-

Earths and Stones. amorphous, and constitutes most frequently the greatest part of the aggregate.

Common granites differ much in their appearance, according to the size, proportion, colour, and figure of their component parts. They are commonly very hard: Their specific gravity varies from 2.5388 to 2.9564.

141 Gneiss. SPECIES 2. Shistose granite or gneiss.

The structure of gneiss is always slaty, and this constitutes its specific character. In gneiss, the proportion of quartz and felspar is nearly equal: the proportion of mica is smallest. It is evidently subject to the same varieties with common granite.

142 G. II. Sienite. GENUS II. Sienite.

Mr Werner has given the name of *sienite* to aggregates composed of felspar, hornblende, and quartz; or of felspar, hornblende, quartz, and mica. These aggregates were formerly confounded with quartz.

Sienite is found both of a granular and slaty structure: it might, therefore, like granite, be divided into two species. In sienite the quartz is commonly in by far the smallest proportion.

143 G. III. Granatine. GENUS III. GRANATINE.

Mr Kirwan has applied the name *granatine* to the following aggregates.

Quartz, Felspar, Shorl.	Quartz, Mica, Garnet.	Quartz, Hornblende, Jade.	Felspar, Mica, Shor
Quartz, Felspar, Jade.	Quartz, Shorl, Hornblende.	Quartz, Hornblende, Garnet.	Felspar, Mica, Hornblende.
Quartz, Felspar, Garnet.	Quartz, Shorl, Jade.	Quartz, Jade, Garnet.	Felspar, Quartz, Serpentine.
Quartz, Mica, Shorl.	Quartz, Shorl, Garnet.	Quartz, Hornblende, Hornstone,	Felspar, Quartz, Steatites.
Quartz, Mica, Jade.			

One of these aggregates, namely, *quartz, mica, garnet*, was called by Cronstedt *morka* or *murksten*.

144 G. IV. Granitell. GENUS IV. GRANITELL.

Mr Kirwan gives the name of *granitell* to all aggregates composed of any two of the following ingredients: quartz, felspath, mica, shorl, hornblende, jade, garnet, steatites. The most remarkable of these are:

Quartz, Felspar.	Quartz, Hornblende.	Quartz, Steatites.	Felspar, Hornblende.
Quartz, Mica.	Quartz, Jade.	Felspar, Mica.	Felspar, Jade.
Quartz, Shorl.	Quartz, Garnet.	Felspar, Shorl.	Felspar, Garnet.

Aggregates.

Mica, Shorl.	Mica, Jade.	Hornblende, Jade.	Jade, Garnet.
Mica, Hornblende,	Mica, Garnet.	Hornblende, Garnet.	Steatites, Shorl.

Some of these aggregates have received particular names. The aggregate of *quartz* and *mica*, when its structure is slaty, is called by Werner *shistose mica*: by the Swedes, it is denominated *stellsten*, whatever be its structure.

The aggregate of hornblende and mica is called *grunstein*, from the dark green colour which it usually has.

GENUS V. GRANILITE. 145 G. V. Granilite.

Under the name of *granilite*, Mr Kirwan comprehends all aggregates containing more than three ingredients. Of these the following are the most remarkable.

Quartz, Felspar, Mica, Shorl.	Quartz, Mica, Shorl, Garnet.	Quartz, Sulph. of barytes, Mica, Shorl.
Quartz, Felspar, Mica, Steatites.	Quartz, Felspar, Mica, Garnet.	Quartz, Sulph. of barytes, Mica, Hornblende.

GENUS VI. TRAP (P). 146 G. VI. Trap.

Under this genus we class not only what has commonly been called *trap*, but also wacken, and mullen, and kragstone of Kirwan.

SPECIES I. Common trap. 147 Common.

This stone is very common in Scotland, and is known by the name of *whinstone*. Whole hills are formed of it; and it occurs very frequently in large rounded detached fragments. Sometimes it assumes the form of immense columns, and is then called *basalt*. The Giants Causeway in Ireland, the island of Staffa, and the south side of Arthur's Seat in Scotland, are well known instances of this figure.

Its texture is earthy or compact. Its fracture uneven. Its lustre commonly 0. Opaque. Hardness 8 to 9. Not brittle. Sp. gr. from 2.78 to 3.021 *. Colour black, with a shade of grey, blue, or purple; sometimes blackish or reddish brown; in some cases greenish grey. By exposure to the atmosphere, it often becomes invested winh a brownish rind. Before the blow-pipe, it melts *per se* into a more or less black glass.

* *Kirwan.*

Trap consists of small crystals of hornblende, felspar, olivine, &c. usually set in a ground composed apparently of clay and oxide of iron. A specimen, in the form of basaltes, from Staffa, analysed by Dr Kennedy of Edinburgh, contained

48	silica,
16	alumina,
16	oxide of iron,
9	lime,
5	moisture,
4	soda,
1	muriatic acid.
99 †	

† *Edin. Transf.* v. 89.

A

(P) *Kirw.* I. 231 and 431.—*Faujas de St Fond. Essai sur l'Hist. Nat. des Roches de Trap.*—*Phil. Transf.* passim. See also a very ingenious set of experiments on the fusion of trap, by Sir James Hall in *Transf. Edin.* V. 43.

Earths and Stones.

A fpecimen from Salifbury rock, near Edinburgh, contained, according to the analyfis of the fame gentleman,

46.0	filica,
19.0	alumina,
17.0	oxide of iron,
8.0	lime,
4.0	moifture,
3.5	foda,
1.0	muriatic acid.
98.5 *	

* Edin. Tranf. v. 90.

Dr Kennedy conducted thefe analyfes with great ingenuity and judgment; and the difcovery in which they terminated, that trap contains foda, is certainly of importance, and may lead to valuable confequences both in a geological and mineralogical view.

148 Wacken.

SPECIES 2. Wacken †.

This ftone often forms confiderable parts of hills, and, like trap, is amorphous. Its texture is earthy. Its fracture ufually even. Luftre 0. Opaque. Hardnefs 6 to 9. Sp. gr. from 2.535 to 2.893 ‡. Colour grey, with a fhade of green, black, red, brown. When expofed to the atmofphere, it withers and becomes more grey.

It melts into a grey porous flag.

† Kirwan, i. 223.

‡ Kirwan.

149 Mullen.

SPECIES 3. Mullen *.

This ftone is alfo found in confiderable maffes, and fometimes has a tendency to a columnar form like bafalt. Texture earthy. Fracture uneven, and fine fplintery. Luftre 0, except from fome fhining particles of bafaltine. Opaque. Hardnefs from 7 to 9. Sp. gr. from 2.6 to 2.738. Colour afh or bluifh grey; fometimes mixed with ochre yellow, in confequence of the decompofition of the ftone. At 130° Wedgewood it melts into a black compact glafs.

When mullen is expofed to the air, its furface becomes covered with a greyifh white rind fometimes flightly ochry.

* Kirwan, i. 225.

150 Kragftone.

SPECIES 4. Kragftone *.

This ftone, which, like the others, forms confiderable parts of rocks, was formed into a diftinct fpecies by Mr Kirwan. Its texture is earthy. It is exceedingly porous, and the pores are often filled with the cryftals of other minerals. Fracture uneven. Luftre 0. Opaque. Hardnefs 5 to 7. Sp. gr. 2.314. Feels rough and harfh. Colour reddifh grey. Streak yellowifh grey. At 138° Wedgewood it melts into a reddifh brown porcelain mafs.

* Kirw. i. 226.

151 G. VII. Porphyry.

GENUS VII. PORPHYRY.

Any ftone which contains fcattered cryftals or grains of felfpar, vifible to the naked eye, is denominated a *porphyry*. Befides felfpar, porphyries generally contain fmall cryftals of quartz, hornblende, and mica. Thefe cryftals are ufually of a different colour from the ftone in which they are found, and they are ftuck in it as in a cement. It is evident from this definition, that the number of porphyries muft be great. Each fpecies receives its name from the ftone which forms its bafis. To defcribe them would be unneceffary. We fhall only give a catalogue of the principal fpecies.

Aggregate.

1. Hornftone porphyry.
2. Pitchftone porphyry.
3. Hornflate porphyry.
4. Felfpar or petunfe porphyry.
5. Clay porphyry.
6. Hornblende porphyry.
7. Trap porphyry.
8. Wacken porphyry.
9. Mullen porphyry.
10. Krag porphyry.
11. Argillitic porphyry.
12. Potftone porphyry.
13. Serpentine porphyry.
14. Sandftone porphyry.

The aggregates belonging to this fection compofe moft of the mountains of the globe. In giving an account of them, we have adhered implicitly to the arrangement moft generally received by mineralogifts. It muft be acknowledged, that this arrangement is by no means complete, and that fome of the genera are too vague to be of much ufe. The number of aggregates already difcovered is too great for giving to each a particular name. Perhaps it would be better henceforth to adopt the method propofed by Mr Hauy, namely, to conftitute the genera from that ingredient which enters moft abundantly into the aggregate, and which forms as it were its bafis, and to diftinguifh the fpecies according to the nature and proportion of the other ingredients. According to this plan, the aggregates hitherto difcovered have been divided by Hauy into the following genera:

1. Felfpathic rock.
2. Quartzous rock.
3. Micaceous rock.
4. Chloritous rock.
5. Serpentine rock.
6. Trappean rock.
7. Hornblendean rock.
8. Petro filiceous rock.
9. Garnetic rock.
10. Calcareous rock.
11. Argillaceous rock.
12. Corneous rock.

SECT. IV. *Volcanic Aggregates.*

AGGREGATES formed by volcanoes may be reduced to the following genera.

1. Lava.
2. Tufa.
3. Pumice.
4. Afhes.

GENUS I. LAVA. 152 G. I. Lava.

All fubftances which have iffued out of a volcano in a ftate of fufion are called *lavas*. They have been divided into three fpecies.

SPECIES 1. Vitreous lava. 153 Vitreous.

Found in fmall pieces.

Texture gloffy. Fracture conchoidal. Luftre 3. Tranfparency from 3 to 1. Hardnefs 9 to 10. Sp. gr. from 2 to 3. Colour blackifh, greenifh, or whitifh. Commonly fomewhat porous.

SPECIES 2. Cellular lava. 154 Cellular.

This fpecies is full of cells. Surface rough and full of cavities. Texture earthy. Luftre 0. Opaque. Hardnefs 7 to 9. Sp. gr. varies, but does not exceed 2.8. Colour brown or greyifh black. Commonly fomewhat magnetic.

SPECIES 3. Compact lava. 155 Compact.

This fpecies is the moft common of all; it runs into the

Combuftibles. the fecond by infenfible degrees; and indeed is feldom found of any confiderable fize without fome pores. It bears in general a very ftrong refemblance to trap.

A fpecimen of the lava of Catania in Sicily, analyfed by Dr Kennedy, contained

51.0	filica,
19.0	alumina,
14.5	oxide of iron,
9.5	lime,
4.0	foda,
1.0	muriatic acid.
99.0 *	

* Tranf. Edin. v. 93.

A fpecimen of the lava of Sta. Venere in Sicily he found to contain

50.75	filica,
17.50	alumina,
14.25	oxide of iron,
10.00	lime,
4.00	foda,
1.00	muriatic acid.
97.5 †	

† Ibid. 94.

Thus we fee, that the refemblance between trap and lava holds not only in their external appearance, but alfo in their component parts.

GENUS II. PUZZOLANA.

Found in fmall pieces. Surface rough. Texture earthy and porous. Fracture uneven. Luftre 0. Opaque. Hardnefs 3. Very brittle. Sp. gr. from 2.57 to 2.8. Colour brown or dark grey. Magnetic. Eafily melts into a black flag. 156 G. II. Puzzolana.

When mixed with lime into a mortar, it poffeffes the property of hardening even under water. This property it owes moft probably, as Mr Kirwan fuppofes, to the iron which it contains. The iron decompofes the water of the mortar, and by this means it becomes too hard to be acted upon by water in a very fhort time.

157 G. III. Pumice.

GENUS III. PUMICE.

This is a very light fubftance ejected from volcanoes. It is porous. Hardnefs 3. Brittle. Sp. gr. below 1. Colour grey or brown.

In fome varieties the luftre and tranfparency are 0: in others, the luftre is glaffy, 2. Tranfparency from 1 to 2.

158 G. IV. Volcanic afhes.

GENUS IV. VOLCANIC ASHES.

Thefe are analogous to the afhes of common pit coal. Loofe and fmooth, very light and fine. Slowly diffufible in water, and when wet fomewhat ductile.

CLASS II. SALTS.

UNDER this clafs we comprehend all the combinations of alkalies with acids which exift in the mineral kingdom. As they have been already defcribed in the article CHEMISTRY, *Suppl.* we fhall here only give a lift of their names.

159 Genera.

GENUS I. POTASS.

Sp. 1. Sulphat of potafs.
2. Nitrat of potafs.

GENUS II. SODA.

Sp. 1. Carbonat of foda.
2. Sulphat of foda.
3. Muriat of foda.
4. Borax.

GENUS III. AMMONIA.

Sp. 1. Sulphat of ammonia.
2. Muriat of ammonia.

CLASS III. COMBUSTIBLES.

160 Genera.

THE combuftible fubftances belonging to the mineral kingdom, excluding the metals, may be comprehended under the following genera.

1. Sulphur.
2. Carbon.
3. Bitumen.
4. Coal.
5. Amber.

161 G. I. Sulphur.

GENUS I. SULPHUR.

SPECIES 1. Native fulphur.

This fubftance is found abundantly in many parts of the world, efpecially near Volcanoes, as Hecla, Ætna, Vefuvius, the Lipari iflands, &c. It is either in the ftate of powder, or maffive, or cryftallized. The primitive form of its cryftals is an octohedron, compofed of two four-fided pyramids, joined bafe to bafe ‡. The fides of thefe pyramids are fcalene triangles, and fo inclined that the plane where the bafes of the pyramids join in a rhomb, whofe long diagonal is to its fhort as 5 to 4 §. Sometimes the apices of the pyramids, to ufe the language of De Lifle, are truncated; fometimes they are feparated from each other by a prifm; fometimes they are truncated near their bafes, and a low four-fided pyramid rifes from the truncature: this pyramid is alfo fometimes truncated near its apex ¶. Finally, one of the edges of the pyramids is fometimes truncated. For figures of thefe varieties and for the laws of their formation, we refer to *Mr Lefroy* *.

‡ Fig. 34.

§ Romé de Lifle, i. 292. Hauy and Lefroy, Jour. de Min. N° xxix. 337.

¶ Fig. 35.

* Jour. de Min. N° xxix. 337.

Colour yellow, with a fhade of green; fometimes reddifh (q). Luftre greafy, 2. Tranfparency varies from 0 to 4. Caufes double refraction †. Texture compact. Hardnefs 4 to 5. Brittle.—For its other properties, we refer to CHEMISTRY in this *Suppl.*

† Hauy.

Sometimes fulphur is mixed with different proportions of earths. Thefe combinations are hardly fufceptible of accurate defcription.

Sulphur combines alfo with metals. Thefe combinations fhall be defcribed in the fourth clafs.

162 G. II. Carbon.

GENUS II. CARBON.

This genus comprehends all minerals compofed of pure carbon, or of carbon combined with a little earth.

163 Diamond.

SPECIES 1. Diamond.

This mineral, which was well known to the ancients, is

(q) It then contains arfenic.

Combuſtibles. is found in different parts of Aſia, particularly in the kingdoms of Golconda and Viſapour; it is found alſo in Brazil.

It is always cryſtallized; but ſometimes ſo imperfectly, that at the firſt ſight it might paſs for amorphous. Its primitive form is a regular octogon †; but it more commonly aſſumes a ſpheroidal form, and then has uſually 36 curvilinear triangular faces, ſix of which are raiſed upon each of the faces of the primitive octogon ‡. Its integrant molecule, according to Hauy, is a regular tetrahedron.—For a more particular account of the cryſtals of this mineral, we refer the reader to *Mr Romé de Liſle* * and *Mr Hauy* †.

Texture foliated. Luſtre 4. Tranſparency from 2 to 4. Cauſes ſingle refraction. Hardneſs 20. Sp. gr. 3.5185 to 3.5310 ‡. Colour various; ſometimes limpid, ſometimes red, orange, yellow, green, blue, and even blackiſh.

When rubebd it becomes poſitively electric, even before it has been cut by the lapidary, which is not the caſe with any other gem ‖.

It is compoſed of pure carbon §.

† Fig. 36.

‡ Fig. 37.

* *Cryſtal.* ii. 191.

† *Jour. de Min.* N° xxix. 343.

‡ *Hauy, ibid.*

‖ *Id. ibid.*

§ *Morveau, Ann. de Chim.* xxxi. 72.

SPECIES 2. Mineral charcoal.

Kilkenny coal—Wales culm.

164 Mineral charcoal. This mineral has been found in Hungary, Italy, France, Ireland, and Wales. It occurs in ſtratified maſſes, or in lumps neſted in clay.

Colour black. Luſtre 4, metallic. Opaque. Texture foliated. Hardneſs 5 to 7. Sp. gr. 1.4 to 1.526, Often ſtains the fingers. Inſoluble in acids. Deflagrates with nitre. Does not burn till wholly ignited, and then conſumes ſlowly without emitting flame or ſmoke.

It conſiſts almoſt entirely of *charcoal*, which, as Morveau has proved, is an oxide of carbon *.

* *Ibid.*

165 Anthracite.

SPECIES 3. Anthracite (R).

Anthracolite.

This ſubſtance, as Dolomieu informs us, is found excluſively in the primitive mountains. It is always amorphous. Colour black or browniſh black. Luſtre 3 to 4. Structure ſlaty. Fragments rhomboidal. Hardneſs 6 to 7. Sp. gr. greater than that of coal. Often ſtains the fingers.

Burns preciſely like the laſt ſpecies, and leaves .40 of white aſhes. According to Dolomieu, it is compoſed of about

64.0	charcoal,
32.5	ſilica,
3.5	iron,
100.0 †	

It is probable that the charcoal in the two laſt ſubſtances is in the ſame ſtate in which it exiſts in plumbago, combined with oxygen, but not containing ſo much as charcoal does ‡.

† *Jour. de Min.* N° xxix. 338.

‡ *Morveau, ibid.*

GENUS III. BITUMEN.

166 G. III. Bitumen. By bitumen we underſtand, with mineralogiſts in general, an oil, which is found in different parts of the earth, in various ſtates of conſiſtence. Theſe different ſtates form diſtinct ſpecies; in our arrangement of which we ſhall be guided by the obſervations which Mr Hatchett has made in his valuable paper on bituminous ſubſtances *.

* *Nicholſon's Journal*, ii. 201, 248.

SPECIES 1. Naphtha.

167 Naphtha. This ſubſtance is found ſometimes on the ſurface of the water of ſprings, and ſometimes iſſuing from certain ſtrata. It is found in great abundance in Perſia.

It is as fluid and tranſparent as water. Colour white or yellowiſh white. Smell ſtrong, but not diſagreeable. Sp. gr. when white, .708 * or .729 †; when yellowiſh, .8475 ‡. Feels greaſy. Catches fire on the approach of flame, burns with a white flame, and leaves ſcarce any reſiduum.

Inſoluble in alcohol. Does not freeze at 0° Fahrenheit. When pure naphtha is expoſed to the air, it becomes yellow and then brown; its conſiſtence is increaſed, and it paſſes into *petroleum* *.

* *Muſchenbroek.*

† *Boulduc.*

‡ *Briſſon.*

* *Hatchett.*

SPECIES 2. Petroleum.

168 Petroleum. This ſubſtance is alſo found in Perſia, and likewiſe in many countries in Europe, particularly Italy, France, Switzerland, Germany, Sweden, England, and Scotland.

Not ſo fluid nor tranſparent as water. Colour yellow, either pale or with a ſhade of red or green; reddiſh brown and reddiſh black. Smell that of naphtha, but leſs pleaſant. Sp. gr. 8783 *. When burned it yields a ſoot, and leaves a ſmall quantity of coally reſiduum.

By expoſure to the air it becomes like tar, and is then called *mineral tar* †.

* *Briſſon.*

† *Hatchett, ibid.*

SPECIES 3. Mineral tar.

169 Mineral tar. This ſubſtance is found in many parts of Aſia, America, and Europe. It is viſcid, and of a black, browniſh black, or reddiſh colour. Smell ſometimes ſtrong, but often faint. Sp. gr. 1.1. When burned, emits a diſagreeable bituminous ſmell. By expoſure to the air it paſſes into *mineral pitch* and *maltha* *.

* *Hatchett, ibid.*

SPECIES 4. Mineral pitch and maltha.

170 Mineral pitch and maltha. This ſubſtance has a ſtrong reſemblance to common pitch. When the weather is warm it is ſoft, and has ſome tenacity; it is then called *adheſive mineral pitch*: when the weather is cold, it is brittle; its hardneſs is 5; and its fracture has a glaſſy luſtre. In this ſtate it is called *maltha*. Colour black, dark brown, or reddiſh. Luſtre 0. Opaque. Sp. gr. from 1.45 to 2.07. Does not ſtain the fingers. On a white hot iron it flames with a ſtrong ſmell, and leaves a quantity of grey aſhes. It it is to the preſence of the earths which compoſe theſe aſhes that the great ſpecific gravity of this bitumen is to be aſcribed. By farther induration, it paſſes into *aſphalt*.

SPECIES 5. Aſphalt.

171 Aſphalt. This ſubſtance is found abundantly in many parts of Europe, Aſia, and America, eſpecially in the iſland of Trinidad.

Colour black or browniſh black. Luſtre greaſy 2. Opaque. Fracture conchoidal, of a glaſſy luſtre. Hardneſs from 7 to 8. Very brittle. Sp. gr. 1.07 to 1.165 *. Feel ſmooth, but not greaſy. Does not ſtain the fingers. Has little or no ſmell, unleſs when rubbed or heated. When heated melts, ſwells, and inflames; and when pure, burns without leaving any aſhes.

* *Kirwan.*

SPECIES 6. Elaſtic bitumen.

Mineral caoutchouc.

172 Elaſtic bitumen. This ſubſtance was found about the year 1786 in the lead

(R) This name was given by Hauy from ἄνθραξ, *a coal*.

Combuſtibles. lead mine of Odin, near Caſtletown, Derbyſhire. It was firſt mentioned by Mr De Born.

Colour yellowiſh or reddiſh brown, ſometimes blackiſh brown. In its appearance it has a ſtrong reſemblance to caoutchouc or Indian rubber; hence its name. Conſiſtency various: ſometimes ſo ſoft as to adhere to the fingers; ſometimes nearly as hard as aſphalt. When ſoft it is elaſtic; when hard brittle. Sp. gr. 0.9053 to 1.0233*.

Inſoluble in alcohol, ether, and oil of turpentine, but ſoluble in oil of olives. Not affected by nitric acid. When diſtilled, it yields a bituminous oil inſoluble in alcohol; the reſiduum is carbonaceous †.

There is a variety of this ſubſtance found in a rivulet near the mine of Odin, which, when freſh cut, exactly reſembles fine cork in colour and texture; but in a few days after being expoſed to the air, becomes of a pale reddiſh brown. This ſubſtance contains within it a nucleus of elaſtic bitumen. It ſeems to be the elaſtic bitumen altered in its texture by the water ‡.

* *Hatchett, ibid.*

† *Lametherie, Jour. de Phyſ.* xxxi. 312.

‡ *Hatchett, ibid.*

173 G. IV. Coal.

Genus IV. COAL.

The ſubſtances belonging to this genus are compoſed of carbon, or rather charcoal, and bitumen.

174 Jet.

SPECIES 1. Jet (s).

This ſubſtance is found in France, Spain, Germany, Britain, and other countries. It is found in detached kidneyform maſſes, of various ſizes, from an inch to ſeven or eight feet in length.

Colour full black. Luſtre 3 to 4; internal glaſſy. Opaque. Hardneſs 7 to 8. Not near ſo brittle as aſphalt. Texture ſtriated. Fracture conchoidal. Sp. gr. 1.259*. It has no odour except when heated, and then it reſembles the odour of aſphaltum. Melts in a ſtrong heat, burns with a greeniſh flame, and leaves an earthy reſiduum †.

Becomes ſomewhat electric by friction ‡. When diſtilled yields a peculiar acid §.

This mineral is formed into buttons, beads, and other trinkets. The manufacture has been almoſt confined to France ‖.

* *Briſſon.*

† *Hatchett.*

‡ *Kirwan.*

§ *Vauquelin.*

‖ *Jour. de Min.* N° iv. 41.

175 Cannel coal.

SPECIES 2. Cannel coal.

This mineral is found in Lancaſhire, and in different parts of Scotland, where it is known by the name of *parrot coal*.

Colour black. Luſtre common, 2. Opaque. Structure ſometimes ſlaty. Texture compact. Fracture conchoidal. Hardneſs 5 to 8. Brittle. Sp. gr. 1.232 to 1.426. Does not ſtain the fingers.

Kindles eaſily, and burns with a bright white flame like a candle (T), which laſts but a ſhort time. It does not cake. It leaves a ſtony or ſooty reſiduum.

A ſpecimen of Lancaſhire cannel coal, analyſed by Mr Kirwan, contained 75.20 charcoal,
21.68 maltha,
3.10 alumina and ſilica.

99.98 ¶

¶ *Mineral.* ii. 523.

A ſpecimen of the ſlaty kind from Airſhire, called *ſplent coal*, was compoſed of
47.62 charcoal,
32.52 maltha,
20.00 earths.

100.14*

* *Ibid.* 524.

Cannel coal is ſuſceptible of poliſh, and, like jet, is often wrought into trinkets.

176 Common coal.

SPECIES 3. Common coal.

This very uſeful combuſtible is never found in the primitive mountains, but only in the ſecondary mountains, or in plains formed of the ſame materials with them. It is always in ſtrata, and generally alternates with clay, ſandſtone, or limeſtone.

Colour black, more or leſs perfect. Luſtre uſually greaſy or metallic, 2 to 4. Opaque. Structure generally ſlaty. Texture often foliated. Fracture various. Hardneſs 4 to 6. Sp. gr. 1.25 to 1.37. Uſually ſtains the fingers. Takes fire more ſlowly, and burns longer, than the laſt ſpecies. Cakes more or leſs during combuſtion.

Of this ſpecies there are many varieties, diſtinguiſhed in Britain by the names of caking coal, rock coal, &c. Theſe are too well known to require any deſcription.

Mr Kirwan analyſed a variety of different kinds of coal: The reſult of his experiments may be ſeen by the following table.

Whitehaven coal.	Wigan.	Swanſey.	Leicester.	
57.0	61.73	73.53	71.43	charcoal.
41.3	36.7	23.14	23.37	maltha & aſph.
1.7	1.57	3.33	5.20	earths †.
100.0	100.00	100.00	100.00	

† *Mineral.* ii. 525.

177 Spurious coal.

SPECIES 4. Spurious coal.

This mineral is generally found amidſt ſtrata of genuine coal. It is alſo called *parrot-coal* in Scotland.

Colour greyiſh black. Luſtre 0 to 1. Structure uſually ſlaty. Texture earthy. Hardneſs 7 to 8. Sp. gr. 1.5 to 1.6. Generally explodes, and burſts when heated.

Compoſed of charcoal, maltha, and aſphalt, and above .20 of ſtony matter.

178 G. V. Amber.

Genus V. AMBER.

SPECIES 1. Common amber.

This ſubſtance, called *electrum* by the ancients, is found in different countries; but moſt abundantly in Pruſſia, either on the ſea-ſhore, or under-ground at the depth of about 100 feet, repoſing on *wood-coal* ‡. It is in lumps of different ſizes.

Colour yellow. Luſtre 3 to 2. Tranſparency 2 to 4. Fracture conchoidal. Hardneſs 5 to 6. Sp. gr. 1.078 to 1.085. Becomes electric by friction.

If a piece of amber be fixed upon the point of a knife, and then kindled, it burns to the end without melting ¶.

By diſtillation it yields ſuccinic acid.

‡ *Kirw. Min.* ii. 66.

¶ *Hauy.*

CLASS

(s) It was called *gagathes* by the ancients, from the river Gages in Licia, near which it was found; *jayet* in French, *ozabache* in Spaniſh, *gagath* in German.

(T) Hence it has been called *cannel coal*. *Candle*, in the Lancaſhire and Scotch dialect, is pronounced *cannel*.

Class IV. METALLIC ORES.

THIS claſs comprehends all the mineral bodies, compoſed either entirely of metals, or of which metals conſtitute the moſt conſiderable and important part. It is from the minerals belonging to this claſs that all metals are extracted; for this reaſon they have obtained the name of *ores*.

179 Orders. The metals hitherto diſcovered amount to 21; we ſhall therefore divide this claſs into 21 orders, allotting a diſtinct order for the ores of every particular metal.

Metals exiſt in ores in one or other of the four following ſtates: 1. In a metallic ſtate, and either ſolitary or combined with each other. 2. Combined with ſulphur. 3. In the ſtate of oxides. 4. Combined with acids. Each order therefore may be divided into the four following genera.

180 Genera.

1. Alloys,
2. Sulphurets,
3. Oxides,
4. Salts.

It muſt be obſerved, however, that every metal has not hitherto been found in all theſe four ſtates, and that ſome of them are hardly ſuſceptible of them all. Some of the orders therefore want one or more genera, as may be ſeen from the following table.

Order I. *Gold ores.*
 1. Alloys.
Order II. *Silver ores.*
 1. Alloys.
 2. Sulphurets.
 3. Oxides.
 4. Salts.
Order III. *Platinum ores.*
 1. Alloys.
Order IV. *Ores of mercury.*
 1. Alloys.
 2. Sulphurets.
 3. Oxides.
 4. Salts.
Order V. *Copper ores.*
 1. Alloys.
 2. Sulphurets.
 3. Oxides.
 4. Salts.
Order VI. *Iron ores.*
 1. Alloys.
 2. Sulphurets.
 3. Carburets.
 4. Silicated iron.
 5. Oxides.
 6. Salts.
Order VII. *Tin ores.*
 1. Sulphurets.
 2. Oxides.
Order VIII. *Lead ores.*
 1. Sulphurets.
 2. Oxides.
 3. Salts.
Order IX. *Zinc ores.*
 1. Sulphurets.
 2. Oxides.
 3. Salts.
Order X. *Antimonial ores.*
 1. Alloys.
 2. Sulphurets.
 3. Oxides.
 4. Salts.
Order XI. *Biſmuth ores.*
 1. Alloys.
 2. Sulphurets.
 3. Oxides.
Order XII. *Arſenic ores.*
 1. Alloys.
 2. Sulphurets.
 3. Oxides.
Order XIII. *Cobalt ores.*
 1. Alloys.
 2. Sulphurets.
 3. Oxides.
 4. Salts.
Order XIV. *Nickel ores.*
 1. Sulphurets.
 2. Oxides.
 3. Salts.
Order XV. *Mangane︎ſe ores.*
 1. Oxides.
 2. Salts.
Order XVI. *Tungſten ores.*
 1. Oxides.
 2. Salts.
Order XVII. *Ores of molybdenum.*
 1. Sulphurets.
Order XVIII. *Ores of uranium.*
 1. Oxides.
 2. Salts.
Order XIX. *Ores of titanium.*
 1. Oxides.
Order XX. *Ores of tellurium.*
 1. Alloys.
Order XXI. *Ores of chromum.*
 1. Oxides.

Order I. GOLD ORES.

No metal perhaps, if we except iron, is more widely ſcattered through the mineral kingdom than gold *. Hitherto it has been found only in a metallic ſtate; moſt commonly in grains, ramifications, leaves, or rhomboidal, octahedral, or pyramidal cryſtals. It is generally mixed with quartz, though there are inſtances of its having occurred in calcareous rocks. It is not uncommon alſo to find it diſſeminated through the ores of other metals; eſpecially iron, mercury, copper, and zinc. The greateſt quantity of gold is found in the warmer regions of the earth. It abounds in the ſands of many African rivers, and is very common in South America and India. Europe, however, is not deſtitute of this metal. Spain was famous in ancient times for its gold mines, and ſeveral of the rivers in France contain it in their ſands †. But the principal gold mines in Europe are thoſe of Hungary, and next to them thoſe of Salzburg. Gold alſo has been diſcovered in Sweden and Norway, and more lately in the county of Wicklow in Ireland ‡.

181 Where found.

* Bergman.

† Reaumur, Mem. Par. 1718, p. 68.

‡ Lloyd, Phil. Tranſ. 1796, p. 36. Mills, ibid. p 38.—Nicholſon's Journ. ii. 224.

Genus I. Alloys of gold.

Species 1. Native gold.

182 G.I. Native gold.

Native gold is never completely pure; it is alloyed with ſome ſilver or copper, and ſometimes with iron. In the native gold found in Ireland, indeed, the quantity of alloy appears to have been exceedingly ſmall.

Its colour is yellow. Luſtre metallic. Fracture hackly. Hardneſs 5. Sp. gr. from 12 to 9.

Order II. SILVER ORES.

183 Where found.

Silver is found moſt commonly in quartz, limeſtone, hornſtone; or combined with the ores of other metals, moſt commonly with copper, antimony, zinc, cobalt, and lead. This laſt metal indeed is ſeldom totally deſtitute of ſilver.

184 G.I. Native ſilver.

Genus I. Alloys of ſilver.

Species 1. Native ſilver *.

Native ſilver, ſo called becauſe the ſilver is nearly in a ſtate of purity, forms the principal part of ſome of the richeſt ſilver mines in the world. It is ſometimes in ſmall lumps; ſometimes cryſtallized in cubes, hexahedrons, octahedrons, or dodecahedrons; ſometimes in leaves, or threads, often ſo connected with each other as to reſemble branches of trees, and therefore called *dendrites*. The ſilver in the famous mines of Potoſi has this laſt form. When newly extracted, it is not unlike ſmall branches of fir †.

The colour of native ſilver is white; often tarniſhed. Luſtre metallic. Fracture hackly. Hardneſs 6. Malleable. Sp. gr. from 10 to 10.338.

The ſilver in this ſpecies is almoſt conſtantly alloyed with from .03 to .05 of ſome other metal, frequently gold or arſenic.

* Kirw. ii. 108.—Calling. Act. Liter. Sveciæ, 1738, p. 120.

† Bergman's Phyſ. Geogr. Jour. de Min. No xvi p. 46.

Silver.

185 Alloy of ſilver and gold.

SPECIES 2. Alloy of ſilver and gold.

Auriferous native ſilver.

This alloy is not uncommon in ſilver mines. Its colour is yellowiſh white. Its luſtre metallic. Hardneſs 5. Malleable. Sp. gr. above 10.6. Dr. Fordyce found a ſpecimen from Norway compoſed of

72 ſilver,
28 gold.

100 *

* *Phil. Tranſ.* 1776, p. 532.

186 Alloy of ſilver and antimony.

SPECIES 3. Alloy of ſilver and antimony †.

Antimoniated ſilver ore.

This alloy, which is found in the ſilver mines of Spain and Germany, is ſometimes in grains or lumps, and ſometimes cryſtallized in ſix-ſided priſms, whoſe ſides are longitudinally channelled ‡.

Its colour is white. Its luſtre metallic. Hardneſs 10. Brittle. Sp. gr. from 9.4406 § to 10.* Texture foliated. Fracture conchoidal. Before the blow-pipe the antimony evaporates in a grey ſmoke, and leaves a browniſh ſlag, which tinges borax green. If borax be uſed at firſt, a ſilver bead may be obtained.

This alloy was long ſuppoſed to contain arſenic. Bergman examined it, and found only ſilver and antimony † His analyſis has been confirmed by the experiments of Vauquelin and Selb ‡. According to Selb, it is compoſed of 89 ſilver,

11 antimony.

100

† *Kirwan*, ii. 110.
‡ *Romé de Liſle*, iii. 461.
§ *Hauy, Jour. de Min.* N° xxx. p. 473.
* *Kirwan, ibid.*
† *Opuſc.* ii. 415.
‡ *Jour. de Min. ibid*

A ſpecimen analyſed by Klaproth, contained

84 ſilver,
16 antimony.

100

Another ſpecimen contained

76 ſilver,
24 antimony.

100 ‡

‡ *Beiträge*, ii. 301.

187 G. II. Sulphurets. Common ſulphuret of ſilver.

GENUS II. SULPHURETS OF SILVER.

SPECIES 1. Common ſulphuret of ſilver *.

Vitreous ſilver ore.

This ore occurs in the ſilver mines of Germany and Hungary. It is ſometimes in maſſes, ſometimes in threads, and ſometimes cryſtallized. Its cryſtals are either cubes or regular octohedrons, whoſe angles and edges are often variouſly truncated. For a deſcription of the varieties produced by theſe truncatures, we refer the reader to *Romé de Liſle* †.

* *Kirwan*, ii. 115.
† *Cryſtal.* iii. 441.

Its colour is dark bluiſh grey, inclining to black; often tarniſhed. Internal luſtre metallic. Texture foliated. Fracture uneven. Hardneſs 4 to 5. May be cut with a knife like lead. Flexible and malleable. Sp. gr. 6.909 ‡ to 7.215 ‖ In a gentle heat the ſulphur evaporates. Melts when heated to redneſs.

‡ *Briſſon.*
‖ *Gellert.*

A ſpecimen of this ore, analyſed by Klaproth, contained

85 ſilver,
15 ſulphur.

100 *

* *Beiträge*, i. 162.

SPECIES 2. Antimoniated ſilver ore *.

Sulphuret of ſilver with antimony and iron.

Metallic ores.

188 Antimoniated ſilver ore.

This ore, which occurs in Saxony and Hungary, ſeems to be ſulphuret of ſilver contaminated with antimony and iron, and ought therefore, in all probability, to be conſidered merely as a variety of the laſt ſpecies. It is ſometimes in maſſes, but more frequently cryſtallized in ſix-ſided priſms, tables, or rhomboids; generally indiſtinct and accumulated together.

* *Kirwan*, ii. 118.

Its colour is iron grey; often tarniſhed. Its luſtre metallic. Fracture uneven. Hardneſs 4 to 5. Brittle. Sp. gr. 7.208 †. Before the blow-pipe the ſulphur and antimony exhale, leaving a bead, which may be freed from iron by fuſion with nitre and borax.

† *Gellert.*

A ſpecimen of this ore, analyſed by Klaproth, contained

66.5 ſilver,
12.0 ſulphur,
10.0 antimony,
5.0 iron,
1.0 ſilica,
0.5 arſenic and copper.

95.0 ‡

‡ *Beiträge*, i. 166.

189 Sulphuret of ſilver and copper.

SPECIES 3. Sulphuret of ſilver and copper ‖

Cupriferous ſulphurated ſilver ore.

This ore, which is found in the Korbolokinſk mountains in Siberia, was firſt deſcribed by Mr Renovantz. It is in amorphous maſſes, varying in ſize from that of the thumb to that of the fiſt.

‖ *Kirwan*, ii. 121.

Its colour is bluiſh grey like lead. Luſtre metallic. Hardneſs 5 to 6. Brittle. Its powder, when rubbed on the ſkin, gives it a black colour and a leaden gloſs. Before the blow-pipe the ſulphuret of ſilver melts readily; that of copper with difficulty. This ore is compoſed of about

42 ſilver,
21 copper,
35 ſulphur.

98

190 G. III. Oxides. Calciform ſilver ore.

GENUS III. OXIDES OF SILVER.

SPECIES 1. Calciform ſilver ore *.

This ore was firſt deſcribed by Mr Widenman. It is ſometimes in maſſes, ſometimes diſſeminated through other minerals.

* *Kirwan*, ii. 112.

Its colour is greyiſh black. Its ſtreak bright. Its luſtre metallic. Its fracture uneven. Hardneſs 4 to 5. Brittle. Sp. gr. conſiderable. Effervefces with acids. Melts eaſily before the blow pipe. Froths with borax.

According to Selb, it contains 72.5 ſilver,

15.5 copper,
12.0 carbonic acid.

100.0

191 Red ſilver ore.

SPECIES 2. Red ſilver ore (U).

This ore is very common in ſeveral German ſilver mines. It occurs in maſſes, diſſeminated and cryſtallized. The primitive form of its cryſtals is a dodecahedron ‡, whoſe ſides are equal rhombs, and which may be con-

‡ Fig. 38.

(U) *Kirw.* II. 122.—*Scopoli de Minera Argenti, Rubra.*—*Sage, Jour. de Phyſ.* XXXIV. 331. *and* XLI. 370; and *Nouv. Jour. de Phyſ.* II. 284.—*Weſtrum, Jour. de Phyſ.* XLIII. 291.—*Klaproth, Beiträge*, I. 141.

Silver.

considered as a six-sided rhomboidal prism, terminated by three-sided summits*. Sometimes the prism is lengthened, and sometimes its edges, or those of the terminating summits, or both, are wanting. For a description and figure of these varieties, we refer to *De Lisle* † and *Hauy* ‡.

** Romé de Lisle*, iii. 447. † *Ibid.* ‡ *Jour. d'Hist. Naturelle*, N° 18. p. 216.

Its colour is commonly red. Streak red. External lustre metallic, internal common. Transparency from 3 to 1; sometimes opaque. Fracture flat conchoidal. Hardness 5 to 7. Brittle. Sp. gr. from 5.44 ‖ to 5.592 *. Becomes electric by friction, but only when insulated †. Soluble in nitric acid without effervescence ‡. Before the blow-pipe melts, blackens, burns with a blue flame, gives out a white smoke with a slight garlic smell, and leaves a silver bead ‖.

‖ *Kirwan.* * *Vauquelin, Jour. de Min.* N° xvii. p. 2. † *Hauy, ibid.* N° xxx. p. 476. ‡ *Hauy, ibid.* N° xxxi. p. 518. ‖ *Vauquelin, ibid.*

Variety 1. Light red.

Colour intermediate between blood and cochineal red; sometimes variegated. Streak orange red. Powder black.

Variety 2. Dark red.

Colour commonly between dark cochineal red and lead grey; sometimes nearly black, and without any shade of red. Streak dark crimson red.

This ore was long supposed to contain arsenic. Klaproth first ascertained its real composition *; and his analysis has been confirmed by Vauquelin, who found a specimen composed of 56.6748 silver,

56.6748	silver,
16.1300	antimony,
15.0666	sulphur,
12.1286	oxygen.
100.	

* *Ann. de Chim.* xviii 81.

Klaproth proved, that the silver and antimony are in the state of oxides; and Vauquelin, that the sulphur is combined partly with the oxide of silver and partly with the oxide of antimony. Klaproth obtained a little sulphuric acid; but this acid, as Vauquelin, with his usual ingenuity, demonstrated, was formed during the analysis.

This ore sometimes contains a minute portion of arsenic, but never more than .02 †.

† *Vauquelin, ibid.* p. 8.

192 G. IV. Salts. Muriat of silver.

GENUS IV. SALTS OF SILVER.

SPECIES 1. Muriat of silver (x).

Corneous silver ore.

This ore occurs at Johanngeorgenstadt in Saxony, in South America, &c. It is often amorphous, sometimes nearly in powder, and sometimes crystallized in cubes or parallelopipeds.

Its colours are various: when exposed to the light it becomes brown. Internal lustre greasy, 2; external, 2 to 1. Acquires a gloss when scraped with a knife. Transparency 2 to 1. Texture foliated. Hardness 4 to 5. Sp. gr. 4 745 ‡ to 4.804 ‖. Before the blow-pipe it instantly melts, and gradually evaporates, but may be reduced by adding an alkali.

‡ *Briss n.* ‖ *Gellert.*

Metallic ores.

That this ore contains muriatic acid, has been long known. Mr Woulfe first shewed that it contained also sulphuric acid *: and this discovery has been confirmed by Klaproth, according to whose analysis this ore is composed of

67.75	oxide of silver,
6.00	oxide of iron,
21.00	muriatic acid,
.25	sulphuric acid,
1.75	alumina.
96.75 †	

* *Phil. Transf.* 1770. † *Beiträge*, i. 134.

The alumina can only be considered as mixed with the ore. Sometimes its quantity amounts to .67 of the whole ‡.

‡ *Ibid.* p. 137.

ORDER III. ORES OF PLATINUM (Y).

193 Mines.

HITHERTO no mine of platinum has been discovered. It is found in small scales or grains on the sands of the river Pinto, and near Carthagena in South America. It is always in a metallic state, and always combined with iron.

GENUS I. ALLOYS OF PLATINUM.

SPECIES 1. Native platinum.

194 G. I. Alloys. Native platinum.

Its colour is whitish iron grey. Magnetic. Sp. gr. from 12 to 16. Soluble in nitro-muriatic and oxy-muriatic acids.

ORDER IV. ORES OF MERCURY.

MERCURY is employed in medicine; it serves to separate silver and gold from their ores; the silvering of looking-glasses, gilding, &c. are performed by means of it; and its sulphuret forms a beautiful paint.

195 Mines.

Mercury abounds in Europe, particularly in Spain, Germany, and Hungary: it is found also in China (Z), the Phillipines ‖, and in Peru, and perhaps Chili (A) in South America. The most productive mines of mercury are those of Idria *; of Almaden, near Cordova in Spain, which were wrought by the Romans (B); of the Palatinate †; and of Guanca Velica in Peru (C).

Mercury has never been found in Britain, nor has any mine worth working been discovered in France. It occurs most commonly in argillaceous shistus, limestones, and sandstones.

‖ *Carreri's Voyage.* * *Scopoli.* † *Jour. de Min.* N° xxxvi. p. 915. *Jour. de Min.* N° vi. and vii.

GENUS I. ALLOYS OF MERCURY.

SPECIES 1. Native mercury.

196. G. I. Alloys Native mercury.

Native mercury is found in most mercurial mines: it is in small globules, scattered through different kinds of stones, clays, and ores.

Fluid. Colour white. Sp. gr. about 13.6.

SPECIES

(X) *Kirw.* II. 113.—*Laxman. Nov. Comm. Petropol.* XIX. 482.—*Monnet, Mem. Sçav. Etang.* IX. 717.

(Y) See *Brownrigg, Phil. Transf.* XLVI. 584.—*Lewis, ibid.* XLVIII. 638. and L. 148.—*Margraf, Mem. Berlin*, 1757, p. 314.—*Macquer, Mem. Par.* 1758, p. 119.—*Buffon, Jour. de Phys.* III. 324.—*Morveau, ibid.* VI. 193.—*Bergman, Opusc.* II. 166.—*Tillet, Mem. Par.* 1779, p. 373, and 385, and 545.—*Crell, Crell's Annals*, 1784. 1 *Band.* 328.—*Willis, Manchester Memoirs*, III. 467.—*Mussin Puschkin, Ann. de Chim.* XXIV. 205.—*Morveau, ibid.* XXV. 3.

(Z) See *Entrecolle's Lettres Edificantes.*

(A) See *Molina's Natural History of Chili.*

(B) See *Bowle's Natural History of Spain*, and *Jour. de Min.* N° xxxi. p. 555.

(C) See *Ulloa's Memoirs concerning America.*

Ores of Mercury.

197 Amalgam of ſilver.

SPECIES 2. Amalgam of ſilver *.

Native amalgam.

This mineral has been found in the ſilver mine of Sahlberg †, in the province of Dalecarlia, in Sweden; in the mines of Deux Ponts ‡, in the Palatinate; and in other places. It is in thin plates, or grains, or cryſtallized in cubes, parallelopipeds, or pyramids.

Its colour is ſilvery white or grey. Luſtre metallic. Creaks when cut. Sp. gr. above 10. Tinges gold white. Before the blow-pipe the mercury evaporates and leaves the ſilver.

A ſpecimen of this amalgam, analyſed by Klaproth, contained 64 mercury,
36 ſilver.
———
100 §

Sometimes it contains a mixture of alumina, and ſometimes the proportion of mercury is ſo great that the amalgam is nearly as ſoft as paſte.

* *Kirwan*, ii. 223.
† *Cronſtedt's Min.*
‡ *Heyer, Crell's Annals*, 1790.
§ *Beiträge*, i. 183.

198 G. II. Sulphurets Common ſulphuret.

GENUS II. SULPHURETS OF MERCURY.

SPECIES 1. Common ſulphuret ||.

Native cinnabar.

This ore, which is found in almoſt all mercurial mines, is ſometimes in veins, ſometimes diſſeminated, ſometimes in grains, and ſometimes cryſtallized. The form of its cryſtals is a tetrahedron or three-ſided pyramid, moſt commonly wanting the ſummit; ſometimes two of theſe pyramids are joined baſe to baſe; and ſometimes there is a three ſided priſm interpoſed between them ¶.

Its colour is red. Its ſtreak red and metallic. Luſtre when cryſtallized 2 to 3; when amorphous, often 0. Tranſparency, when cryſtallized, from 1 to 3; when amorphous, often 0. Texture generally foliated. Hardneſs from 3 to 8. Sp. gr. from 5.419 to 10.1285.

Before the blow-pipe evaporates with a blue flame and ſulphureous ſmell. Inſoluble in nitric acid *.

Variety 1. Dark red.

Colour cochineal red. Hardneſs 6 to 7. Sp. gr. when pure, 10.1285 †; ſometimes only 7.2, or even 6.188 ‡.

Variety 2. Bright red.

Colour commonly ſcarlet. Sp. gr. 6.9022 § to 5.419 ||.

|| *Kirwan*, ii. 228.
¶ *Romé de Liſle*, iii. 154.
* *Hauy, Jour. de Min.* N° xxxi. p. 518.
† *Briſſon.*
‡ *Muſchenbroek.*
§ *Briſſon.*
|| *Gellert.*

199 G. III. Oxides. Hepatic mercurial ore.

GENUS III. OXIDES OF MERCURY.

SPECIES 1. Hepatic mercurial ore ¶.

This ore, which is the moſt common in the mines of Idria, is always amorphous, and is often mixed with native mercury and cinnabar.

Its colour is ſomewhat red. Its ſtreak dark red and brighter. Luſtre commonly metallic. Hardneſs from 6 to 8. Sp. gr. from 9.2301 * to 7.186 †. When heated the mercury evaporates.

Though this ore has never been accurately analyſed, chemiſts have concluded that the mercury which it contains is in the ſtate of a red oxide, becauſe it is inſoluble in nitric and ſoluble in muriatic acid ‡. When pureſt, it contains about .77 of mercury §. It contains alſo ſome ſulphur and iron.

Werner has divided this ſpecies into two varieties, the *compact* and the *ſlaty*. The ſecond is often nothing more than bituminous ſhale impregnated with oxide of mercury ||.

¶ *Kirwan*, ii. 224
* *Briſſon.*
† *Kirwan.*
‡ *Sage, Jour. de Phyſ.* xxiv. 61.
§ *Scopoli, Jour. de Min.* N° xxxvi. p. 919.
|| *Kirwan*, ii. 226.

Metallic Ores.

200 Mercurial Salts. Muriat of mercury.

GENUS IV. MERCURIAL SALTS.

SPECIES 1. Muriat of mercury *.

Corneous mercury.

This ore, which occurs in the Palatinate, is ſometimes in ſcales, ſometimes in grains, and ſometimes cryſtallized. Its cryſtals are either ſmall four or ſix ſided priſms whoſe ſides are rhombs †, or cubes, or four-ſided pyramids wanting their angles. They are always very ſmall and generally confuſed.

Its colours are various; but it is moſt frequently white. Its luſtre, when white, is pearly. Sometimes opaque, and ſometimes ſemitranſparent. Evaporates before the blow-pipe.

Mr Woulfe diſcovered that this ore generally contains ſome ſulphuric acid ‡. Specimens have been found in which the quantity of ſulphuric acid exceeds that of the muriatic §.

* *Kirwan*, ii. 226.
† *Romé de Liſle*, iii. 161.
‡ *Phil. Tranſ.* lxvi. 618.
§ *Suckow.*

ORDER V. COPPER ORES.

MANY of the moſt uſeful utenſils are formed of copper: it enters largely into the compoſition of braſs, bronze, and bell metal; not to mention the dyes and paints of which it is the baſis.

201 Mines.

Copper mines abound in moſt countries. They are wrought in China, Japan, Sumatra; the north of Africa; in Chili and Mexico; and in moſt parts of Europe; eſpecially Britain, Germany, Ruſſia, Hungary.

Copper is found moſt commonly in rocks of hornblende, ſhiſtus, and quartz.

202 G. I. Alloys. Native copper.

GENUS I. ALLOYS OF COPPER.

SPECIES 1. Native copper ||.

Native copper occurs now and then in the greater number of copper mines: Sometimes it is in maſſes, ſometimes in plates and threads, which aſſume a variety of forms; and ſometimes, as in Siberia, it is cryſtallized in cubes, or other forms nearly reſembling cubes §.

Colour commonly that of copper, but ſometimes dark brown. Luſtre metallic. Streak brighter. Fracture hackly. Flexible and malleable. Hardneſs 6 to 7. Sp. gr. from 7.6 * to 8.5844 †.

|| *Kirwan*, ii. 127.—*Cartheuſer.*
§ *Hauy, Jour. de Min.* N° xxxi. 509.
* *Kirwan, Min.* ii. 128.
† *Hauy, ibid.* p. 509.

203 White copper ore.

SPECIES 2. White copper ore ‡.

Alloy of copper, iron, and arſenic.

This ore, which is ſaid to be uncommon, occurs in maſſes. Colour white. Luſtre metallic. Fracture uneven. Hardneſs 8 to 9. Brittle. Sp. gr. conſiderable.

Before the blow-pipe gives out a white arſenical ſmoke, and melts into a greyiſh black ſlag §.

‡ *Kir. Min.* ii. 152.
§ *Widenman.*

204 G. II. Sulphurets. Copper. Common ſulphuret of copper.

GENUS II. SULPHURETS OF COPPER.

SPECIES 1. Common ſulphuret of copper ||.

Vitreous copper ore.

This ore, which is found in Cornwall, Hungary, and Siberia, occurs in maſſes, plates, threads, and cryſtallized in ſix-ſided priſms, or four-ſided pyramids, joined baſe to baſe.

Colour bluiſh grey. Streak brighter grey. Luſtre metallic. Hardneſs 4 to 7. Sp. gr. 5.452 ¶ to 5.565 *; ſometimes ſo low as 4.129 †. Detonates with nitre.

Before the blow-pipe it melts eaſily; and while the fuſion exhibits a green pearl, which, on cooling, is covered with a brown cruſt. Tinges borax green.

Werner makes two varieties of this ore: the firſt he calls

|| *Kirwan*, ii. 144.
¶ *Kirwan*,
* *Gellert.*
† *Kirwan.*

Copper Ores.

calls *compact*, from its fracture; and the ſecond, for the ſame reaſon, he calls *foliated*. This laſt is ſomewhat darker coloured than the firſt, but in other reſpects they agree.

205 Copper pyrites.

SPECIES 2. Copper pyrites *.

Yellow copper ore.

This ore, which is probably nothing elſe than ſulphuret of iron combined with copper, and which, therefore, would be more properly placed among iron ores, is found frequently in copper mines, and mixed with common pyrites or ſulphuret of iron. It is ſometimes amorphous, and ſometimes cryſtallized. Its cryſtals are either three or four ſided pyramids applied baſe to baſe, or ſix-ſided plates.

Its colour is yellow; often tarniſhed. Its internal luſtre metallic. Hardneſs 6 to 7; ſometimes 9. Brittle. Sp. gr. 4.314 † to 4.08 ‡. Deflagrates; but does not detonate with nitre §.

Before the blow-pipe decrepitates, gives a greeniſh ſulphureous ſmoke, and melts into a black maſs, which tinges borax green. Does not effervesce with nitric acid.

* *Kirwan*, ii. 140.

† *Briſſon.*

‡ *Kirwan*, § *Id. Min.* ii. 141.

206 Purple copper ore.

SPECIES 3. Purple copper ore ||.

This ore is found in maſſes, or plates, or diſſeminated; ſometimes, alſo, it is cryſtallized in octahedrons. Colour various, but moſt commonly purple; internally reddiſh. Streak reddiſh and bright. Luſtre metallic. Hardneſs 6 to 7. Brittle. Sp. gr. 4.956 to 4.983 ¶.

Effervesces with nitric acid, and tinges it green. Deflagrates with nitre. Before the blow-pipe melts readily, without ſmoke, vapour, or ſmell; but is not reduced. Tinges borax a bright green.

A ſpecimen of this ore, analyſed by Klaproth, contained

58	copper,
18	iron,
19	ſulphur,
5	oxygen.
100 †	

|| *Kirwan*, ii. 142.

¶ *Ibid.* ii. 143.

† *Beitráge*, ii. 186.

207 Grey copper ore.

SPECIES 4. Grey copper ore ‡.

This ore is found in Cornwall, Saxony, Hungary, &c. It is often amorphous, but often alſo cryſtallized. The primitive form of its cryſtals is the regular tetrahedron; but, in general, either the angles or the edges, or both, are truncated or bevelled §.

Colour ſteel grey; often tarniſhed, and then dark grey. Streak dark grey; ſometimes reddiſh brown. Powder blackiſh; ſometimes with a tint of red. Luſtre metallic. Hardneſs 7 or 8. Very brittle. Sp. gr. 4.8648 ||. Deflagrates with nitre. Before the blow-pipe crackles, but at laſt melts, eſpecially if aſſiſted by borax. The bead gives a white ſmoke, without any particular ſmell; tinges borax yellow or browniſh red, but does not unite with it.

A ſpecimen of this ore from Cremnitz, analyſed by Klaproth, contained

31	copper,
14	ſilver,
34	antimony,
3	iron,
11	ſulphur.
93	

‡ *Kirwan*, ii. 146.

§ *Romé de Liſle*, iii. 345.

|| *Hauy. Jour. de Min.* N° xxxi. 512.

Napion, in an ore from the valley of Lanzo, found copper, ſilver, and antimony, nearly in the ſame proportions, but more iron, and ſome arſenic *. Savoreſi, as Baron Born informs us, beſides the ingredients of Klaproth's analyſis, found ſome gold and mercury in grey copper ore †: and Klaproth himſelf found lead in moſt of the other ſpecimens which he examined.

* *Mem. Turin*, v. 173.

† *Catal.* ii. 498.

208 G. III. Oxides. Red oxide of copper.

GENUS III. OXIDES OF COPPER.

SPECIES 1. Red oxide of copper ‡.

Florid red copper ore—Red copper glaſs.

This ore is found in Cornwall, and many other countries. It occurs in maſſes, diſſeminated, in ſcales, and cryſtallized. The figure of its cryſtals is moſt commonly the octahedron §.

Colour commonly cochineal red. Streak brick red. Luſtre ſemimetallic. Tranſparency, when amorphous, generally 0; when cryſtallized, 3 or 4. Hardneſs from 4 to 7. Soluble with effervescence in nitric acid. Before the blow-pipe melts eaſily, and is reduced.

This ore was ſuppoſed to be compoſed of carbonic acid and red oxide of copper; but a ſpecimen, examined by Vauquelin, which conſiſted of pure cryſtals, contained no acid ||. It muſt therefore be conſidered as an oxide of copper.

Werner has made three varieties of this ore, which, from their texture, he has denominated *compact*, *foliated*, and *fibrous*. The firſt is ſeldom or never found cryſtallized, and is opaque; the ſecond occurs amorphous, cryſtallized, and in ſcales; the third is carmine, ruby, or ſcarlet red; and occurs always in ſhort capillary cryſtals, or delicate flakes.

This ore ſometimes contains a mixture of red oxide of iron; it is then called *brick red copper ore*, *copper malm*, or *copper ochre*.

This ore is ſometimes mixed with bitumen. Its colour is then browniſh black, and it is called *pitch ore*.

‡ *Kirwan*, ii. 135.

§ *Hauy, Jour. de Min.* N° xxxi. 517.

|| *Ibid.*

209 Green oxide of copper.

SPECIES 3. Green oxide of copper *.

Green ſand of Peru.

This ore, which was brought from Peru by Dombey, is a graſs green powder, mixed with grains of quartz. When thrown on burning coals, it communicates a green colour to the flame. It is ſoluble both in nitric and muriatic acids without effervescence. The ſolution is green. It was ſuppoſed to contain muriatic acid †; but Vauquelin has diſcovered that the appearance of this acid was owing to the preſence of ſome common ſalt, which is accidently mixed with the ſand ‡.

* *Kirwan*, ii. 149.

† *Berthollet, Mem. Par.* 1786, 462.

‡ *Jour. de Min.* N° xxxi. 519.

210 G. IV. Salts. Blue carbonat of copper.

GENUS IV. SALTS OF COPPER.

SPECIES 1. Blue carbonat of copper (D).

Mountain blue—Azure de cuivre—Blue calx of copper—Kupfer lazur.

This ore, which occurs in the copper mines of Siberia, Sweden, Germany, Hungary, Cornwal, &c. is either amorphous or cryſtallized. The cryſtals are ſmall, and difficult to examine. According to Romé de Liſle, their primitive form is an octahedron, the ſides of which are iſoſceles triangles, and two of them more inclined than the others §. Be that as it may, the cryſtals of blue carbonat of copper are often rhomboidal priſms, either regular, or terminated by dihedral ſummits ||.

Its colour is azure or ſmalt blue. Streak blue. Hardneſs

§ *Cryſtal.* iii. 343.

|| *Ibid.* p. 345.

(D) *Kirwn.* II. 129.—*Morveau, Mem. Dijon*, 1782. 1 *Semeſtre*, p. 100.

Copper Ores.

neſs 4 to 6. Brittle. Sp. gr. 3.608 ‡. It effervefces with nitric acid, and gives it a blue colour. Before the blow-pipe it blackens, but does not melt. Tinges borax green with effervefcence.

‡ *Briſſon.*

The cryſtals, according to Pelletier, are compoſed of

66 to 70 copper,
18 — 20 carbonic acid,
8 — 10 oxygen,
2 — 2 water.

Fontana firſt diſcovered that this ore contained carbonic acid gas.

Variety 1. Earthy blue carbonat.

Mountain blue.

This variety generally contains a mixture of lime. It is never cryſtallized; and ſometimes is almoſt in the ſtate of powder. Luſtre 0. Texture earthy.

Variety 2. Striated blue carbonat of copper.

Luſtre glaſſy. Tranſparency, when cryſtallized, 2; when amorphous, 1. Texture ſtriated; ſometimes approaching to the foliated.

211 Green carbonat of copper.

SPECIES 2. Green carbonat of copper (E).

Oxygenated carbonat of copper—Malachite.

This ore is generally amorphous, but ſometimes it is cryſtallized in four-ſided priſms, terminated by four-ſided pyramids.

Colour green. Luſtre ſilky. Hardneſs 5 to 7. Brittle. Sp. gr. 3.571 * to 3.653 ‡. Effervefces with nitric acid, and gives a blue colour to ammonia. Before the blow-pipe it decrepitates and blackens, but does not melt. Tinges borax yellowiſh green. It is compoſed of carbonic acid and green oxide of iron.

* *Briſſon.*
‡ *Kirwan.*

Variety 1. Fibrous malachite.

Texture fibrous. Opaque when amorphous; when cryſtallized its tranſparency is 2. Colour generally graſs green.

Variety 2. Compact malachite.

Texture compact. Opaque. Colour varies from the dark emerald green to blackiſh green.

A ſpecimen of malachite from Siberia, analyſed by Klaproth, contained

58.0 copper,
18.0 carbonic acid,
12.5 oxygen,
11.5 water.

100 *

* *Beiträge*, ii. 290.

This ſpecies is ſometimes mixed with clay, chalk, and gypſum, in various proportions; it is then known by the name of

Common mountain green.

Its colour is verdigris green. Luſtre 0. Tranſparency 0 to 1. Hardneſs 3 to 4. Brittle. Texture earthy. Effervefces feebly with acids. Before the blow-pipe it exhibits the ſame phenomena with malachite.

212 Sulphat of copper.

SPECIES 3. Sulphat of copper.

For a deſcription of this ſalt, ſee CHEMISTRY, n° 648. in this *Supplement*.

213 Arſeniat of copper.

SPECIES 4. Arſeniat of copper ‡.

Olive copper ore.

‡ *Kirwan*, ii. 151.

This ore is found at Cararach in Cornwal. It is generally cryſtallized in ſix-ſided compreſſed priſms. Its colour is olive green. Streak ſometimes ſtraw coloured, ſometimes olive green. Luſtre glaſſy. Tranſparency from 4 to 2. Fracture conchoidal. Hardneſs 4 to 7. Before the blow-pipe deflagrates with an arſenical ſmoke, and melts into a grey coloured bead. This bead, fuſed with borax, leaves a button of pure copper ‖.

Metallic Ores.

‖ *Klaproth's Obſervations on Cornwal*, p. 29.

Klaproth diſcovered that it was compoſed of oxide of copper and arſenic acid.

Sometimes this ore is combined with iron. It then cryſtallizes in cubes. Theſe cubes are of a dark green colour; before the blow-pipe they frothe, give out an arſenical ſmoke, and do not ſo quickly form a grey bead as the arſeniat of copper *.

* *Ibid.* p. 29.

ORDER VI. IRON ORES.

To deſcribe the uſes of iron, would be to write the hiſtory of every art and manufacture, ſince there is not one which is not more or leſs dependent upon this uſeful metal. Nor is its abundance inferior to its utility. It exiſts almoſt everywhere, and ſeems, as it were, the bond which connects the mineral kingdom together.

214. Mines.

GENUS I. ALLOYS OF IRON.

215 G. I. Alloys. Native iron.

SPECIES 1. Native iron (F).

Native iron has been found in Siberia and in Peru in immenſe maſſes, which ſeemed as if they had been fuſed. Theſe maſſes evidently did not originate in the place where they were found. See *FIRE-balls, Suppl.*

Colour bluiſh white. Fracture hackly. Luſtre metallic. Malleable. Magnetic. Hardneſs 8 to 9. Sp. gr. 7.8. Prouſt has diſcovered, that the native iron found in Peru is alloyed with nickel ¶.

¶ *Nicholſon's Jour.* iii. 374.

GENUS II. SULPHURETS OF IRON.

SPECIES 1. Common ſulphuret of iron *.

Pyrites.

216. G. III. Sulphurets. Common ſulphuret of iron.

This mineral occurs very frequently both in ores and mixed with other bodies, for inſtance in ſlates. It is often amorphous, and often alſo cryſtallized. The primitive form of its cryſtals is either a regular cube or an octohedron. The varieties of its form hitherto deſcribed amount to 30; for a deſcription of which we refer the reader to *Romé de Liſle* †.

* *Kirwan*, ii. 76.—*Henkel's Pyritologia.*
† *Cryſtal.* iii. 208.

Its colour is yellow. Its luſtre metallic. Hardneſs 8 to 10. Brittle. Sp. gr. 3.44 to 4.6. Soluble in nitric acid with effervefcence. Scarce ſoluble in ſulphuric acid. Before the blow-pipe burns with a blue flame and a ſulphureous ſmell, and leaves a browniſh bead, which tinges borax of a ſmutty green.

Variety 1. Common pyrites.

Fracture uneven. Hardneſs 10. Decrepitates when heated. Emits a ſulphureous ſmell when rubbed. Not magnetic. It occurs often in coal mines and in ſlates.

Variety 2. Striated Pyrites.

Texture ſtriated. Hardneſs 10. Not magnetic.

Variety 3. Capillary.

Colour often ſteel grey. Found in needle-form cryſtals. Uncommon. Not magnetic.

Variety 4. Magnetic pyrites.

Found in maſſes. Texture compact. Hardneſs 8, 9. Slightly magnetic. Seems to contain leſs ſulphur than the other varieties.

In pyrites the proportion of the ſulphur to the iron is variable; and this explains the variety of its cryſtalline forms.

GENUS

(E) *Kirw.* II. 131.—*Fontana, Jour. de Phyſ.* XI. 509.—*Klaproth, Beiträge*, II. 287.

(F) *Pallas, Phil. Tranſ.* LXVI. 523.—*Rubin de Celis, ibid.* LXVIII. 37.—See alſo *Schreiber, Jour. de Phiſ.* XLI. 3.; and *Stelin, Phil. Tranſ.* LXIV. 461.

Iron Ores.

217 G. III. Plumbago.

Genus III. Carburet of Iron.

Species 1. Plumbago *.

Graphite of Werner.

This mineral is found in England, Germany, France, Spain, America, &c. It occurs in kidney-form lumps of various fizes. Its colour is dark iron grey or brownifh black; when cut, bluifh grey. Luftre metallic, from 3 to 4. Opaque. Structure flaty. Texture fine grained. Hardnefs 4 to 5. Brittle. Sp. gr. from 1.987 to 2.089; after being foaked in water 2.15; after being heated 2.3, and when heated after that 2.41 †. Feels fomewhat greafy. Stains the fingers, and marks ftrongly. The ufe of this mineral when manufactured into pencils is known to every perfon.

* Kirwan, ii. 58.

† Briffon.

Its compofition was difcovered by Scheele. When pure it contains 90 carbon,

10 iron.

100

But it is often exceedingly impure: A fpecimen, for inftance, from the mine of Pluffier, in France, analyfed by Vauquelin, contained 23 carbon,

2 iron,

38 filica,

37 alumina.

100 ‡

‡ Jour. de Min. N° xii. p. 16.

218. G. IV. Emery.

Genus IV. Iron combined with Silica.

Species 1. Emery *.

This mineral is commonly diffeminated through other foffils, but fometimes in the Eaft Indies it occurs in large maffes.

* Kirwan, ii. 193.

Its colour is bluifh grey, greyifh brown, or bluifh black, often covered with a yellowifh rind; internally it difcovers red or purple fpots. Luftre 1 or 0; in fome parts 2, and metallic. Opaque. Hardnefs 14. Brittle. Sp. gr. 3.92 †. Before the blow-pipe it blackens and gives a fmutty yellow tinge to borax.

† Briffon.

According to Wiegleb it contains

95.6 filica,

4.3 iron.

99.9

219 G. V. Oxides.

Genus V. Oxides of Iron.

This genus is very extenfive; for iron is much more frequently found in the ftate of an oxide than in any other.

220 Black oxide of iron.

Species 1. Black oxide of iron ‡.

Common magnetic iron ftone—Blackifh octohedral iron ore.

‡ Kirwan, ii. 158.

This fpecies of ore is very common in Sweden; it is found alfo in Switzerland, Norway, Ruffia, &c. It occurs in maffes, plates, grains, and cryftallized. The primitive form of its cryftals is a regular octohedron †. Sometimes two oppofite fides of the pyramids are trapeziums, which renders the apex of the pyramids cuneiform. Sometimes the cryftals pafs into rhomboidal parallelopipeds, and into dodecahedrons with rhomboidal faces §.

† Rome de Lifle, iii. 178.

§ Ibid.

Its furface is brownifh black; internally bluifh grey. Powder black *. Streak blackifh grey, brighter. Luftre metallic. Hardnefs 9 to 10. Brittle. Sp. gr. from 4.094 to 4.688 †. Attracted by the magnet, and generally poffeffed of more or lefs magnetic virtue ‡. To this fpecies belongs the magnet. Before the blow-pipe it becomes browner, but does not melt. Tinges borax dark green.

* Hauy, Jour. de Min. N° xxxiii. 659.

† Kirwan's Min. ii. 159.

‡ Hauy, Jour. de Min. N° xxxi. 527.

Metallic Ores.

When pure it confifts entirely of oxide of iron; and this oxide appears to contain from .15 to .24 oxygen, and from .76 to .85 iron §. Undoubtedly it confifts of a mixture of iron in two different ftates of oxidation. It is often alfo mixed and contaminated with foreign ingredients.

§ Kirwan, Min. ii. 159.

There are two varieties of this ore. The firft is what we have juft defcribed; the fecond is in the form of fand, and has therefore been called

Magnetic fand *.

This fubftance is found in Italy, Virginia, St. Domingo, the Eaft Indies, and in the fand of the river Don at Aberdeen in Scotland. It is black, very hard, magnetic. Sp. gr. about 4.6 Not altered by the blowpipe *per fe*; melts into a black glafs with potafs, and into a green glafs with microcofmic falt, both opaque †. It probably contains fome filica, as Kirwan has fuppofed ‡.

* Kirwan, ii.—Dupuget, Jour. de Min. N° xxi. p. 75.

† Fourcroy, Ann. de Chim. ii. 127.

‡ Min. ii. 161.

221 Specular iron ore.

Species 2. Specular iron ore ¶.

Fer oligifte.

This ore is found abundantly in the ifle of Elba near Tufcany. It is either in maffes or cryftallized. The primitive form of its cryftals, and of its integrant molecules, is the cube *. The varieties hitherto obferved amount to 7. Thefe are the rhomboidal parallelopiped; the cube, with three triangular faces inftead of two of its angles diagonally oppofite; two fix-fided pyramids, applied bafe to bafe, wanting the fummits ‡, and fometimes the angles at the bafes, and fometimes the alternate edges of the pyramid; a polyhedron of 24 fides, refembling a cube with three triangular faces for two angles diagonally oppofite, and two triangles for the reft of its angles. For a defcription and figure of thefe varieties, we refer to *Romé de Lifle* † and *Hauy* ‡.

¶ Kirw. ii. 162.—Coudrai, Jour. de Phyf. iv. 52.

* Hauy, Jour. de Min. N° xxxiii. 660.

‡ Fig. 39.

† Cryft. iii. 189.

‡ Ibid. 660.

Colour fteel grey; often tarnifhed, and beautifully iridefcent, reflecting yellow, blue, red. Streak red. Powder dark red. Luftre metallic. Hardnefs 9 to 10. Not brittle. Sp. gr. 5.0116† to 5.218 ‡. Slightly magnetic. Little altered by the blow-pipe. Tinges borax an obfcure yellow.

† Hauy,
‡ Briffon.

This ore, according to Mr Mufhet, is compofed of

66.1 iron,

21.2 oxygen,

10.7 water and carbonic acid,

2.0 lime.

100.0 †

† Philof. Mag. iii. 354.

The quantity of oxygen here ftated is probably too fmall, owing to the unavoidable inaccuracy which refults from the *dry way* of analyfis which Mr Mufhet followed.

Micaceous iron ore

Is generally confidered as a variety of this fpecies. Kirwan, however, fuppofes it to contain carbon, and to be a diftinct fpecies.

It is found in Saxony, and in the ifle of Elba, &c. generally in amorphous maffes, compofed of thin fixfided laminæ. Colour iron grey. Streak bluifh grey. Luftre metallic. Opaque. Feels greefy. Hardnefs 5 to 7. Brittle, Sp. gr. from 4.5 to 5.07. Slightly magnetic.

Iron Ores. magnetic. Infusible by the blow-pipe. Tinges borax greenish brown.

222 Laminated specular iron ore.

SPECIES 3. Laminated specular iron ore.

Fer pyroceti of Hauy.

This ore, which is found at Montd'or in Auvergn, was usually arranged under the last species; but has been separated from it, we think properly, by Mr Hauy, because the form of its crystals is incompatible with the supposition that their primitive nucleus is a cube, as we have seen is the case with common specular iron ore. Its crystals are thin octagonal plates, bounded by six linear trapeziums, alternately inclined different ways *.

Colour steel grey. Powder reddish black. Lustre metallic; surface polished. Fracture glassy. Very brittle †. Hauy supposes that this ore has been produced by fire, and accordingly has given it a name which denotes its origin.

* De Lisle, iii. 188.

† Hauy, Jour. de Min. N° xxxi. 33.

223 Brown iron ore.

SPECIES 4. Brown iron ore ‡.

This species of ore is found abundantly in Britain, particularly in Cumberland and Lancashire; and it is also very common in other counties. It consists of the brown oxide of iron, more or less contaminated with other ingredients.

‡ Kirw. ii. 163.

Its colour is brown. Its streak reddish brown. Sp. gr. from 3.4771 to 3.951. Before the blow-pipe blackens, but does not melt. Tinges borax greenish yellow.

Variety 1. Brown hæmatites.

The name hæmatites (bloodstone) was probably applied by the ancients only to those ores which are of a red colour, and have some resemblance to clotted blood; but by the moderns it is applied to all the ores of iron which give a reddish coloured powder, provided they be of a fibrous texture.

Brown hæmatites occurs in masses of various shapes, and it is said also to have been found crystallized in five or six sided acute angled pyramids. Colour of the surface brown or black, sometimes iridescent; internally nut brown. Powder red. Texture fibrous. Hardness 8 to 10. Brittle. Sp. gr. 3.789 § to 3.951 ‖. Not magnetic.

§ Gellert.

‖ Kirwan.

This variety has not been analysed, but it seems to consist of brown oxide of iron, oxide of manganese, and alumina ¶.

¶ Kirwan's Min. ii. 164.

Variety 2. Compact brown iron stone.

This variety occurs in masses of very various and often fantastical shapes.

Colour brown. Internal lustre metallic. Texture compact. Hardness 6 to 9. Brittle. Sp. gr. 3.4771 * to 3.551 †.

* Brisson.

† Kirwan.

Variety 3. Brown scaly iron ore.

This variety is generally incumbent on other minerals. Colour brown. Lustre metallic. Stains the fingers, marks strongly. Feels unctuous. Texture foliated. Hardness 3 to 5. Brittle. So light as often to float on water.

Variety 4. Brown iron ochre.

This variety occurs both massive and disseminated. Colour from nut brown to orange. Lustre 0. Strongly stains the fingers. Texture earthy. Hardness 3 to 4. When slightly heated reddens.

224 Red iron ore.

SPECIES 5. Red iron ore ‡.

‡ Kirw. ii. 168.

Colour red. Streak blood red. Sp. gr. from 3.423 to 5.005. Before the blow-pipe blackens, but does not melt. Tinges borax yellowish olive green. When digested in ammonia, it becomes black and often magnetic.

Metallic Ores.

Variety 1. Red hæmatites.

Found in masses, and all the variety of forms of stalactites. Colour between brownish red and steel grey. Powder red. Internal lustre metallic. Texture fibrous. Hardness 9 to 10. Brittle. Sp. gr. 4.74 * to 5.005 †.

* Gellert.

† Kirwan.

When pure it consists of red oxide of iron, but it often contains manganese and alumina ‡.

‡ Kirwan's Min. ii. 169.

Variety 2. Compact red iron ore.

Found massive and stalactitic; sometimes in crystals of various forms, but they seem to be only secondary; sometimes in columns like basalt.

Colour between brown red and steel grey. Stains the fingers. Lustre 1 to 0; often semimetallic. Texture compact. Hardness 7 to 9. Brittle. Sp. gr. 3.423 to 3.76 §. Sometimes invested with a rosy red ochre.

§ Kirwan.

Variety 3. Red ochre.

Found sometimes in powder, sometimes indurated. Colour blood red. Stains the fingers. Lustre 0. Texture earthy. Hardness 3 to 5. Brittle.

Variety 4. Red scaly iron ore.

This variety is generally found incumbent upon other iron ores. Colour between cherry red and steel grey. Stains the fingers. Lustre silky, inclining to metallic. Texture foliated. Feels unctuous. Hardness 3 to 4. Brittle. Heavy.

225 Argillaceous iron ore.

SPECIES 6. Argillaceous iron ore ‖.

Oxid of iron combined or mixed with clay.

This ore is exceedingly common; and though it contains less iron than the species already described, it is, in this country at least, preferred to them, because the method of extracting pure iron from it is easier, or rather because it is better understood.

‖ Kirw. ii. 173.

Colour most commonly dark brown. Streak red or yellowish brown. Sp. gr. from 2.673 to 3.471 *. Before the blow-pipe blackens, and tinges borax olive green and blackish. It is composed of oxide of iron, alumina, lime, silica in various proportions. It generally yields from 30 to 40 *per cent.* of iron.

* Kirwan.

Variety 1. Common argillaceous iron ore.

The minerals arranged under this variety differ considerably from each other in their external characters. They are found in masses of various shapes, and often form large strata.

Colour various shades of grey, brown, yellow, and red. Streak reddish yellow or dark red. Lustre 0. Hardness from 3 to 8. Smell earthy when breathed upon.

Variety 2. Columnar or scapiform iron ore.

This variety is found in columns, adhering to each other, but easily separable: They are commonly incurvated, and their surface is rough. Colour brownish red. Streak dark red. Slightly stains the fingers. Lustre 0. Adheres strongly to the tongue. Sound hollow. Feel dry. Texture earthy.

Variety 3. Acinose iron ore.

This variety is found in masses, and is commonly lenticular. Colour generally brownish red. Lustre metallic, nearly. Texture granular. Hardness 5 to 9. Brittle.

Variety

Iron Ores.

Variety 4. Nodular, or kidney-form iron ore.
Ætites or *Eagleſtone*.

This variety, which was mentioned by the ancients, is generally found under the form of a rounded knob, more or leſs reſembling a kidney, though ſometimes it is quadrangular; and it contains within it a kernel, which is ſometimes looſe, and ſometimes adheres to the outſide rind. Colour of the ſtone yellowiſh brown; of the kernel ochre yellow. Surface generally fouled with earth. Luſtre of the rind metallic; of the kernel 0. Hardneſs from 4 to 7. Brittle.

Variety 5. Piſiform or granular iron ore.

This variety occurs in rounded maſſes, from the ſize of a pea to that of a nut. Surface rough. Colour commonly dark brown. Streak yellowiſh brown. Hardneſs 5 to 6. Brittle.

The oolitic ore found at Creuſot, near mount Cenis, belongs to this variety. It is compoſed of

50	lime,
30	iron,
20	alumina.
100	

226 Lowland iron ore.

SPECIES 7. Lowland iron ore *.

This ſpecies of ore is ſuppoſed to conſiſt of oxide of iron, mixed with clay and phoſphuret or phoſphat of iron. It is called lowland ore, becauſe it is found only in low grounds; whereas the laſt ſpecies is more commonly in high grounds; and is therefore cally *highland ore*.

* *Kirw.* ii. 179.

This ore occurs in amorphous maſſes, and alſo in grains or powder. Its colour is brown. Streak yellowiſh brown. Luſtre 0, or common. Texture earthy. Hardneſs 3 to 5.

Variety 1. Meadow lowland ore.

Colour blackiſh or yellowiſh brown: Both colours often meet in the ſame ſpecimen. Found in lumps of various ſizes, often perforated. Fracture compact. Moderately heavy.

Frequently yields from 32 to 38 *per cent.* of iron.

Variety 2. Swampy iron ore.

This variety is generally found under water. It is in lumps, which are commonly perforated or corroded, and mixed with ſand. Colour dark yellowiſh brown, or dark nut brown. Hardneſs 3 to 4. Brittle. Sp. gr. 2.944. It often contains .36 of iron.

Variety 3. Moraſſy iron ore.

This variety is found either in a looſe form or in perforated lumps. Colour light yellowiſh brown. Stains the fingers. Hardneſs 3. Friable.

227 G. VI. Salts. Sparry iron ore.

GENUS VI. SALTS OF IRON.

SPECIES 1. Sparry iron ore (G).

This ore is common in Germany, France, and Spain. It is found ſometimes in amorphous maſſes, and ſometimes cryſtallized.

Metallic Ores.

Its colour is white; but it becomes tarniſhed by expoſure to the air, and then aſſumes various colours. Streak grey or white. External luſtre often metallic; internal common or glaſſy. Tranſparency 1 or 2; ſometimes 0. Texture foliated. Fragments rhomboidal. Hardneſs 5 to 7. Brittle. Sp. gr. 3.6 to 3.810. Not magnetic. Soluble in acids with very little efferveſcence. Before the blow-pipe decrepitates, becomes browniſh black, and magnetic; but is ſcarcely fuſible. Tinges borax ſmutty yellow, with ſome efferveſcence.

This ore, as Bergman aſcertained, conſiſts of iron, mangeneſe, lime, and carbonic acid.

One ſpecimen, according to his analyſis, contained

38	iron,
24	manganeſe,
38	carbonat of lime.
100	

Another contained

22	iron,
28	manganeſe,
50	carbonat of lime.
100	

Whether the iron be combined with the carbonic acid is ſtill a diſputed point. The cryſtals of this ore are rhomboidal parallelopipeds; which is preciſely the form of carbonat of lime. This amounts nearly to a demonſtration, that the carbonic acid is combined with the lime; and that, as Cronſtedt and Hauy have ſuppoſed, this ore is merely carbonat of lime, contaminated with a quantity of the oxids of iron and manganeſe.

228 Arſeniat of iron.

SPECIES 2. Arſeniat of iron.

Mr Prouſt has diſcovered this ore in Spain. Its colour is greeniſh white. Its texture granular. Inſoluble in water and nitric acid. When melted on charcoal, the arſenical acid eſcapes with efferveſcence *.

* *Ann. de Chim.* i. 195.

229 Sulphat of iron.

SPECIES 3. Sulphat of iron.

For a deſcription of this ſalt, ſee CHEMISTRY, n° 631. in this *Suppl.*

ORDER VII. TIN ORES (H).

TIN is employed to cover plates of iron and copper, and to ſilver the backs of looking glaſſes: It enters into the compoſition of pewter; and forms a very important article in dyeing.

230 Mines.

Tin ores are by no means ſo common as the ores of the metals which we have already deſcribed. They are found only in the *primitive mountains* (1). Hence Werner ſuppoſes them to be the moſt ancient of all metallic ores. They occur moſt frequently in granite, ſometimes in porphyry, but never in limeſtone.

Almoſt

(G) *Kirw.* II. 190.—*Bergman*, II. 184.—*Bayen. Jour. de Phyſ.* VII. 213.— *Razowmowſki, Mem. Lauſanne*, 1783, p. 149.

(H) *Geoffroy, Mem. Par.* 1738, p. 103.—*Morveau, Ann. de Chim.* XXIV. 127.

(1) Geologiſts have divided mountains into three claſſes; *primitive*, *ſecondary*, and *tertiary*. The *primitive* occupy the centre of all extenſive chains; they are the higheſt, the moſt rugged, and exhibit the moſt pointed tops. They are conſidered as the moſt ancient mountains of the globe.

The *ſecondary* mountains occupy the outſide of extenſive ranges. They are uſually compoſed of ſtrata, more or leſs inclined, and commonly reſt againſt the ſides of the primitive mountains.—The *tertiary* mountains are much ſmaller than the others, and are often ſolitary. We uſe the terms *primitive*, *ſecondary*, &c. merely as proper

Tin Ores.

Almoſt the only tin mines known to Europeans are thoſe of Cornwal, Devonſhire, Saxony, Bohemia, Sileſia, Hungary, Gallicia; thoſe of the iſland of Banca and the peninſula of Malacca in India; and thoſe of Chili and Mexico and America.

231
G. I. Sulphurets. Sulphuret of tin and copper

Genus I. sulphurets of tin.

species 1. Sulphuret of tin and copper *.

Tin pyrites.

Hitherto this ore has only been found in Cornwal. There is a vein of it in that county, in the pariſh of St Agnes, nine feet wide, and twenty yards beneath the ſurface †.

Its colour is yellowiſh grey, paſſing into the ſteel grey. Not unlike grey copper ore. Luſtre metallic. Hardneſs 5 to 6. Very brittle. Sp. gr. 4.35 ‡. Before the blow-pipe it melts eaſily, with a ſulphureous ſmell, into a black bead, and depoſits a bluiſh oxide on the charcoal.

The compoſition of this ore, as Klaproth informs us, was firſt diſcovered by Mr Raſpe. According to Klaproth's analyſis, it is compoſed of

34 tin,
36 copper,
25 ſulphur,
3 iron,
2 earth.

100 §.

* *Kirw.* ii. 200.
† *Klaproth's Cornwal*, p. 21.
‡ *Klaproth.*
§ *Id.* 58.

232
G. II. Oxides. Brown oxide of tin

Genus II. oxides of tin.

species 1. Brown oxide of tin *.

Tinſtone—Woodtin.

This ore, which may be conſidered as almoſt the only ore of tin, occurs in maſſes, in rounded pieces, and cryſtallized. Theſe cryſtals are very irregular. Hauy ſuppoſes, that their primitive form is a cube †; but Romé de Liſle, with more probability, makes it an octohedron ‡; and in this opinion Mr Day agrees with him ||. The octohedron is compoſed of two four-ſided pyramids, applied baſe to baſe. The ſides of the pyramids are iſoſceles triangles, the angle at the vertex of which is 70°, and each of the other angles 55°. The ſides of the two pyramids are inclined to each other at an angle of 90° §. The primitive form, however, never occurs, but cryſtals of tinſtone are ſometimes found, in which the two pyramids are ſeparated by a priſm. For a complete deſcription of the varieties of the cryſtals of tinſtone, we refer the reader to *Romé de Liſle* and *Mr Day* *.

* *Kirw.* ii. 197.
† *Jour. de Min.* N° xxxii. 576.
‡ *Cryſtallog.* iii. 413.
|| *Philoſ. Mag.* iv. 152.
§ *Romé de Liſle, ibid.*

Metalic Ores.

* *Philoſ. Mag. ibid.*

Its colour is commonly brown. Streak grey. Hardneſs 9 to 10. Sp. gr. 6.9 to 7.0. Brittle.

Variety 1. Common tinſtone.

Colour dark brown; ſometims yellowiſh grey, and ſometimes nearly white. Streak light grey. Somewhat tranſparent when cryſtallized. Hardneſs 10. Sp. gr. 6.9 to 6.97. Before the blow-pipe it decrepitates, and on charcoal is partly reduced. Tinges borax white.

According to Klaproth, it is compoſed of

77.50 tin,
21.50 oxygen,
.25 iron,
.75 ſilica.

100.00 †

† *Beiträge*, ii. 256.

Variety 2. Woodtin.

This variety has hitherto been found only in Cornwal. It occurs always in fragments, which are generally rounded. Colour brown; ſometimes inclining to yellow. Streak yellowiſh grey. Opaque. Texture fibrous. Hardneſs 9. Sp. gr. 7.0. Before the blow-pipe becomes browniſh red; decrepitates when red hot, but is not reduced.

Klaproth obtained from it .63 of tin; and, in all probability, it is an oxide of tin nearly pure.

Order VIII. ORES OF LEAD.

The uſeful purpoſes to which lead in its metallic ſtate is applied, are too well known to require deſcription. Its oxides are employed in painting, in dyeing, and ſometimes alſo in medicine.

Ores of lead occur in great abundance in almoſt every part of the world. They are generally in veins; ſometimes in ſiliceous rocks, ſometimes in calcareous rocks.

233
G. I. Sulphurets, Galena, or pure ſulphuret of lead.

Genus I. sulphurets of lead.

species 1. Galena, or pure ſulphuret of lead ‡.

This ore, which is very common, is found both in maſſes and cryſtallized. The primitive form of its cryſtals is a cube. The moſt common varieties are the cube, ſometimes with its angles wanting, and the octohedron, compoſed of two four-ſided pyramids applied baſe to baſe: The ſummits of theſe pyramids are ſometimes cuneiform, and ſometimes their ſolid angles are wanting ||.

Its colour is commonly bluiſh grey, like lead. Streak bluiſh grey and metallic. Luſtre metallic. Sometimes ſtains

‡ *Kirw.* ii. 216.
|| *Romé de Liſle*, iii. 364.

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proper names, without affirming or denying the truth or falſehood of the theory on which theſe names are founded. That the reader may have a more accurate idea of the compoſition of theſe different claſſes of mountains, we have ſubjoined a liſt of the ſubſtances which, according to Werner, enter into the compoſition of each.

I. Primary Mountains.

1. Granite,
2. Gneiſs,
3. Micaceous ſhiſtus,
4. Argillaceous ſhiſtus,
5. Syenite,
6. Porphyry,
7. Shiſtoſe porphyry,
8. Quartz,
9. Primitive limeſtone,
10. Serpentine,
11. Topaz rock.

II. Secondary Mountains.

1. Argillaceous ſhiſtus,
2. Rubble ſtone,
3. Secondary limeſtone,
4. Shiſtoſe hornblende,
5. Grunſtein,
6. Amygdaloid.

III. Tertiary Mountains.

1. Trap,
2. Argillaceous ſhiſtus,
3. Stratified limeſtone,
4. Sandſtone,
5. Breccia,
6. Coal,
7. Chalk,
8. Sulphat of lime,
9. Rock ſalt,
10. Ferruginous clay,
11. Potters earth.

Ores of Lead.

stains the fingers. Texture foliated. Fragments cubical. Hardness 5 to 7; sometimes even 9. Brittle. Sp. gr. 6.884 to 7.786 §. Effervesces with nitric and muriatic acids. Before the blow-pipe decrepitates, and melts with a sulphureous smell; part sinks into the charcoal.

§ Watson.

It is composed of from .45 to .83 lead, and from .086 to .16 of sulphur. It generally contains some silver, and sometimes also antimony and zinc.

Variety 1. Common galena.

This variety corresponds nearly with the above description. Sp. gr. 7.051 to 7.786. Sometimes stains the fingers.

Compact galena.

Found only in amorphous masses. Texture compact, inclining to foliated. Hardness 6 to 8. Sp. gr. 6.886 to 7.444. Lustre common. Streak lead grey, brighter and metallic. Often feels greasy, and stains the fingers.

234 Sulphuret of lead, with silver and antimony.

SPECIES 2. Sulphuret of lead, with silver and antimony*.

Plumbiferous antimoniated silver ore.

Found in amorphous masses. Colour grey. Hardness 5 to 6. Brittle. Sp. gr. from 5.2 to 8.

* Kirw. ii. 219.

Variety 1. Light grey silver ore.

Colour light bluish grey. Streak light bluish grey, and brighter. Lustre metallic. Texture compact. Before the blow-pipe partly evaporates, and leaves a silver bead on the charcoal, surrounded by yellow dust.

According to Klaproth, it contains

48.06	lead,
20.40	silver,
7.88	antimony,
12.35	sulphur,
2.25	iron,
7.00	alumina,
.25	silica.
98.09 †	

† Beiträge, i. 171.

Variety 2. Dark grey silver ore.

Colour iron grey, verging on black. Powder black, and stains the fingers. Lustre 0, Texture earthy.

According to Klaproth, it contains

41.00	lead,
21.50	antimony,
29.25	silver,
22.00	sulphur,
1.75	iron,
1.00	alumina,
.75	silica.
97.25 ‡	

‡ Ibid. 175.

235 Blue lead ore.

SPECIES 3. Blue lead ore*.

* Kirw. ii. 220.

This ore, which is found in Siberia, Germany, and Hungary, and is very rare, occurs sometimes in masses, and sometimes crystallized in six-sided prisms.

Colour between indigo blue and lead grey; sometimes inclining to black. Internal lustre metallic. Streak brighter. Texture compact. Hardness 6. Sp. gr. 5.461 †. Before the blow-pipe melts with a low blue flame and a sulphureous smell, and is easily reduced.

† Gellert.

236 Black lead ore.

SPECIES 4. Black lead ore ‡.

‡ Kirw. 221.

This ore, which is found in Germany and Brittanny, and which is supposed to be common galena decayed, is sometimes in stalactites of various forms, and sometimes crystallized in six-sided prisms, which are generally truncated and confused.

Metallic Ores.

Colour black, often with some streaks of red. Streak light bluish grey. Internal lustre metallic. Hardness 5 to 6. Brittle. Sp. gr. from 5.744 ‖ to 5.77*. Before the blow-pipe decrepitates, melts easily, and is reduced.

‖ Brisson. * Gellert.

According to the experiments of Laumont, this ore is a sulphuret of lead (or rather sulphuret of oxide of lead), mixed with some phosphat of lead.

237 Sulphuret of lead, bismuth, and silver.

SPECIES 5. Sulphuret of lead, bismuth, and silver.

This ore, which occurs in the valley of Schapbach in Saxony, was first taken notice of by Selb, and afterwards described by Weidenmann and Emerling.

Its colour is light bluish grey. Its lustre metallic Its fracture uneven. Hardness 5. Melts easily before the blow-pipe, emitting some smoke, and leaves a silver bead.

A specimen, analysed by Mr Klaproth, contained

33.0	lead,
27.0	bismuth,
15.0	silver,
16.3	sulphur,
4.3	iron,
0.9	copper.
96.5 †	

† Beiträge, ii. 297.

238 G. II. Oxides. Lead ochre.

GENUS II. OXIDES OF LEAD.

SPECIES 1. Lead ochre ‡.

‡ Kirw. ii. 205.

This ore, which is a mixture of the oxide of lead with various earths, is found massive, and various degrees of hardness.

Its colour is either yellow, grey, or red. Lustre 0. Transparency 0 to 1. Hardness 6 to 8; sometimes in powder. Sp. gr. from 4.165 to 5.545 §. Texture compact. Effervesces with nitric and muriatic acids. Easily reduced by the blow-pipe, leaving a black slag, unless the lead be mixed with too great a proportion of earth.

§ Kirwan.

239 G. III. Salts. Carbonat of lead.

GENUS III. SALTS OF LEAD.

SPECIES 1. Carbonat of lead ‡.

White lead spar.

‡ Kirw. ii. 203.

This ore of lead, which is very common, is sometimes in masses, and sometimes crystallized. But the crystallization is in general so confused, that the primitive form of the crystals has not yet been ascertained (K).

Its colour is white. External lustre, waxy or silky, from 3 to 1; internal 1 to 2. Generally somewhat transparent. Hardness 5 to 6. Brittle. Sp. gr. from 5.349 ‖ to 6.92 §. Effervesces with nitric and muriatic acids when they are heated. Soluble in fat oils. Blackened by sulphuret of ammonia*. Decrepitates when heated. Before the blow-pipe, in a silver spoon, it becomes red by the yellow cone of the flame, while the blue cone renders it yellow †. On charcoal it is immediately reduced.

‖ Kirwan. § Gellert. * Pelletier, Ann. de Chim. ix. 56. † Ribbentropp, Ann. de Chim. xxv. 189.

It contains from .60 to .85 of lead, and from .18 to .24 of carbonic acid. It is generally contaminated with carbonat of lime and oxide of iron.

SPECIES

(K) See *Hauy, Jour. de Min.* N° XXXI. 502. and *Romé de Lisle*, III. 380.

Ores of Lead.

240 Phofphat of lead.

SPECIES 2. Phofphat of lead *.

This ore, which is found in Siberia, Scotland, England, Germany, Carinthia, Brittany, &c. is fometimes amorphous, and fometimes cryftallized. The primitive form of its cryftals, according to Romé de Lifle, is a dodecahedron, confifting of a fix-fided rectangular prifm, terminated by fix-fided pyramids, the fides of which are ifofceles triangles (L). Sometimes the pyramids are truncated, and even altogether wanting. The cryftals of this ore are often acicular.

* *Kirw.* ii. 207.

Its colour is commonly green; fometimes yellowifh or brownifh, or greyifh white. Streak commonly greenifh white. Powder yellowifh. External luftre, waxy, 2 to 3. Somewhat tranfparent, except when its colour is greyifh white. Hardnefs 5 to 6. Brittle. Sp. gr. from 5.86* to 6.27†. Infoluble in water and fulphuric acid, and nearly infoluble in nitric acid; foluble in hot muriatic acid, with a flight effervefcence ‡. Before the blow-pipe it eafily melts on charcoal, and cryftallizes on cooling: with foda the lead is in fome meafure reduced.

* *Briffon.*
† *Klaproth.*
‡ *Fourcroy, Ann. de Chim.* ii. 207.

The compofition of this ore was firft difcovered by Gahn.

According to Fourcroy's analyfis, a fpecimen from Erlenbach in Alface confifts of

96	phofphat of lead,
2	phofphat of iron,
2	water.
100	

Or it contains

79	oxide of lead,
1	oxide of iron,
18	phofphoric acid,
2	water.
100¶	

¶ *Ibid.*

241 Arfeniat of lead.

SPECIES 3. Arfeniat of lead §.

This ore, which has hitherto been found only in Andalufia in Spain, and always in quartz or feldfpar, is in fmall maffes. Colour meadow green, often paffing into wax yellow. Luftre waxy, 2. Tranfparency 2. Before the blow-pipe it melts, and retains its colour, and does not cryftallize on cooling. When heated to whitenefs, the arfenic acid efcapes, and the lead is reduced*.

§ *Kirw.* ii. 209.
* *Prouft, Jour. de Phyf.* xxx. 394.

242 Phofphat and arfeniat of lead.

SPECIES 4. Phofphat and arfeniat of lead.

Aefenio phofphat of lead †.

This ore, which has been found in Auvergne in France, is either in maffes, or cryftallized in fmall fix-fided prifms, with curvilineal faces.

Colour yellowifh green, or fhews alternate layers of pale and light green. Powder yellowifh. The cryftals are fomewhat tranfparent; but when maffive, this ore is opaque. Hardnefs 5 to 7. Brittle. Sp. gr. 6.8465 ‡. Soluble in hot muriatic acid, but not in nitric. When heated it decrepitates. Before the blow-pipe melts eafily, effervefces, emits a white fmoke, with an arfenical fmell. Some particles of lead are reduced, a brown fluid remains, which cryftallizes on cooling like phofphat of lead.

† *Kirw.* ii. 210.
‡ *Briffon.*

Metallic Ores.

According to Fourcroy, from whom the whole of this defcription has been taken, it is compofed of

65	arfeniat of lead,
27	phofphat of lead,
5	phofphat of iron,
3	water.
100*	

* *Ann. de Chim.* ii. 23.

243 Molybdat of lead.

SPECIES 5. Molybdat of lead (M).

This ore, which is found in Carinthia and at Leadhills in Scotland, was firft mentioned in 1781 by Mr Jacquin (N). It occurs either in maffes, or cryftallized in cubic, or rhomboidal, or octohedral plates.

Its colour is yellow. Streak white. Luftre waxy. Generally fomewhat tranfparent. Texture foliated. Fracture conchoidal. Hardnefs 5 to 6. Sp. gr. 5.486†; when purified from its gangue by nitric acid, 5.706 ‡. Soluble in fixed alkalies and in nitric acid. Communicates a blue colour to hot fulphuric acid. Soluble in muriatic acid, and decompofed by it. Before the blow-pipe decrepitates, melts into a yellowifh grey mafs, and globules of lead are reduced ‖.

† *Macquart.*
‡ *Hatchett.*
‖ *Macquart.*

Klaproth firft proved that this ore was molybdat of lead.

A very pure fpecimen, analyfed by him, contained

64.42	oxide of lead,
34.25	molybdic acid,
98.67¶	

¶ *Beiträge,* ii. 275.

According to the analyfis of Mr Hatchett, it is compofed of

58.40	oxide of lead,
38.00	molybdic acid,
2.10	oxide of iron,
.28	filica.
98.78*	

* *Phil. Tranf.* lxxxvi. 323.

Macquart found a fpecimen to contain

58.74	lead,
4.76	oxygen,
28.00	molybdic acid,
4.50	carbonat of lime,
4.00	filica.
100.00†	

Its gangue is carbonat of lime.

† *Jour. de Min.* N° xvii. 32.

244 Sulphat of lead.

SPECIES 6. Sulphat of lead *.

This ore, which is found in Anglefey and in Andalufia, is generally cryftallized. The cryftals are regular octahedrons †, and very minute.

Colour white. Luftre 4. Tranfparency 4. Before the blow-pipe it is immediately reduced.

The compofition of this ore was firft afcertained by Dr Withering.

* *Kirw. Min.* ii. 211.
† *Hauy, Jour. de Min.* N° xxxi. 508.

ORDER IX. ORES OF ZINC.

HITHERTO zinc has not been applied to a great variety of ufes. It enters into the compofition of brafs; it is ufed in medicine; and Morveau has fhewn that its oxide

(L) *Cryftal.* III. 391. See alfo *Hauy's* remarks on the fame fubject in the *Jour. de Min.* N° XXXI. 506.
(M) *Kirw.* II. 212.—*Klaproth, Ann. de Chim.* VIII. 103.—*Hatchett, Phil. Tranf.* 1796, p. 285.
(N) In his *Mifcellanea Auftriaca,* Vol. II. p. 139.

Ores of Zinc.

oxide might be employed with advantage as a white paint.

Ores of zinc are very abundant; they generally accompany lead ores, particularly galena. Calamine, or oxide of zinc, has never been diſcovered in the primitive mountains.

245 G. I. Sulphurets. Common ſulphuret of zinc.

GENUS I. SULPHURETS OF ZINC.

SPECIES I. Common ſulphuret of zinc *.

Blende.

This ore very commonly accompanies ſulphuret of lead. It occurs both in amorphous maſſes and cryſtalliſed. The primitive form of its cryſtals is a rhomboidal dodecahedron, conſiſting of a ſix-ſided priſm, terminated by three-ſided pyramids. All the faces of the cryſtals are equal rhombs. This dodecahedron may be mechanically divided into four equal rhomboidal parallelopipeds, and each of theſe into ſix tetrahedrons, whoſe faces are equal iſoſceles triangles. The figure of its integrant particles is the tetrahedron, ſimilar to theſe †.

The principal varieties of its cryſtals are the tetrahedron; the octohedron; the octohedron with its edges wanting ‡; a 24-ſided cryſtal, 12 of whoſe faces are trapezoids, and 12 elongated triangles §; and, laſtly, a 28-ſided figure, which is the laſt variety, augmented by four equilateral triangles ‖.

Colour yellow, brown, or black. Streak reddiſh, browniſh, or grey. Luſtre commonly metallic. Generally ſomewhat tranſparent. Texture foliated. Hardneſs 6 to 8. Sp. gr. 3.93 * to 4.1665 †. Before the blow-pipe decrepitates, and gives out white flowers of zinc, but does not melt. Borax does not affect it. When breathed upon, loſes its luſtre, and recovers it very ſlowly ‡.

* *Kirw.* ii. 238.—*Berg.* ii. 329.

† *Hauy, Jour. de Min.* N° xxxii. 669.

‡ Fig. 40.

§ Fig. 41.

‖ See *Hauy, ibid.* and *Romé de Liſle*, iii. 65.

* *Gillert.*

† *Briſſon.*

‡ *Hauy, Jour. de Min. ibid.*

Variety 1. Yellow blende.

Colour commonly ſulphur yellow, often paſſing into olive green or browniſh red. Powder pale yellow. Streak yellowiſh or reddiſh grey, not metallic. Luſtre metallic. Tranſparency 2 to 4. Often phoſphoreſces when ſcraped or rubbed §.

According to Bergman, it is compoſed of

64	zinc,
20	ſulphur,
5	iron,
4	fluor acid,
1	ſilica,
6	water.
100 ‖	

§ *Bergman*, ii. 345.

‖ *Ibid.* 347.

Variety 2. Brown blende.

Colour different ſhades of brown. Surface often tarniſhed. Powder browniſh grey. Streak reddiſh or yellowiſh grey, not metallic. Luſtre commonly metallic. Tranſparency 0 to 2.

A ſpecimen of this variety, analyſed by Bergman, contained

44	zinc,
17	ſulphur,
24	ſilica,
5	iron,
5	alumina,
5	water.
100 ¶	

¶ *Ibid.* 333.

Variety 3. Black blende.

Colour black, or browniſh black; ſurface often tarniſhed blue; tips of the cryſtals often blood red. Powder browniſh black. Streak reddiſh, browniſh, or grey. Luſtre common or metallic. Tranſparency 0 to 1; the red parts 2. Hardneſs 8.

Metallic Ores.

A ſpecimen of this variety, analyſed by Bergman, contained

52	zinc,
26	ſulphur,
4	copper,
8	iron,
6	ſilica,
4	water.
100 *	

* *Bergman*, ii. 335.

246 G. II. Oxides. White oxide of zinc.

GENUS II. OXIDES OF ZINC.

SPECIES I. White oxide of zinc †.

Calamine.

This ore is either found looſe, or in maſſes, or cryſtallized. The primitive form of its cryſtals appears, from the mechanical diviſion of one of them by Mr Hauy, to be an octohedron compoſed of two four-ſided pyramids, whoſe ſides are equilateral triangles ‡. But the cryſtals are minute, and their figure not very diſtinct. They are either four or ſix-ſided tables with bevelled edges, ſix-ſided priſms, or three-ſided pyramids.

† *Kirw.* ii. 233.—*Berg.* ii. 321.

‡ *Jour. de Min.* N° xxxii. 596.

Colour commonly white, grey, or yellow. Luſtre often 0, ſometimes 2 or 1. Opaque. The cryſtals are ſomewhat tranſparent. Hardneſs from 4 to 9, ſometimes in powder. Sp. gr. from 2.585 to 3.674 §. When heated, becomes electric, without friction, like the tourmaline ‖. Not blackened by ſulphuret of ammonia. Soluble in ſulphuric acid. Before the blow-pipe decrepitates, and does not melt.

§ *Kirwan.*

‖ *Hauy, Jour. de Min. ibid.*

This ore conſiſts of oxide of zinc more or leſs contaminated with iron, ſilica, lime, and other foreign ingredients. In one ſpecimen Bergman found the following ingredients:

84	oxide of zinc,
3	oxide of iron,
12	ſilica,
1	alumina.
100 ¶	

¶ *Bergman*, ii. 323.

In another ſpecimen, which gelatinized with acids like zeolite, Klaproth found

66	oxide of zinc,
33	ſilica,
99	

In another ſpecimen, analyzed by Pelletier, the contents were

52	ſilica,
36	oxide of zinc,
12	water.
100 *	

* *Jour. de Phyſ.* xx. 428.

Mr Kirwan has divided this ſpecies into three varieties.

Variety 1. Friable calamine.

In maſſes which eaſily crumble between the fingers. Luſtre 0. Opaque. Texture earthy. When its colour is white, it is pure oxide of zinc; when yellow, it is mixed with oxide of iron. The white often becomes yellow when placed in a red heat, but reſumes its colour on cooling. Common in China, where it is called *wohan* or *ore of Tutenago*.

Ores of Antimony.

Variety 2. Compact calamine.

Colour different ſhades of grey; ſometimes yellow or browniſh red. Luſtre 0. Opaque. Texture compact.

Variety 3. Striated calamine.

This variety alone is found cryſtallized; but, like the others, it is alſo often amorphous. Colour white, and alſo various ſhades of grey, yellow, and red. Somewhat tranſparent. Texture ſtriated. Luſtre 2 to 1.

247 G. III. Salts. Sulphat of zinc.

GENUS III. SALTS OF ZINC.

SPECIES 1. Sulphat of zinc.

For a deſcription of this ſalt, we refer to CHEMISTRY, n° 643. *Suppl.*

ORDER X. ORES OF ANTIMONY.

Antimony is much uſed to give hardneſs to thoſe metals which otherwiſe would be too ſoft for certain purpoſes: printers types, for inſtance, are compoſed of lead and antimony. It is uſed alſo in medicine.

Ores of antimony are found abundantly in Germany, Hungary, France, Spain, Britain, Sweden, Norway, &c. They often accompany galena and hæmatites. They are found both in the ſecondary and primitive ſtratified mountains. Their gangue (o) is often quartz and ſulphat of barytes.

248 G. I. Alloys Native antimony. * Kirw. ii. 245.

GENUS I. ALLOYS OF ANTIMONY.

SPECIES 1. Native antimony *.

This mineral, which was firſt diſcovered by Dr Swab, has been found in Sweden and in France, both in maſſes and kidney ſhaped lumps. Colour white, between that of tin and ſilver. Luſtre metallic. Texture foliated. Hardneſs 6. Sp. gr. above 6. Deflagrates with nitre. Before the blow-pipe melts and evaporates, depoſiting a white oxide of antimony.

It conſiſts of antimony, alloyed with 3 or 4 *per cent.* of arſenic.

249 G. II. Sulphurets. Grey ore of antimony. * Kirw. ii. 247. † Romé de Liſle, iii. 49. ‡ Ibid.—See alſo Hauy, Jour. de Min. N° xxxii. 606. § Briſſon.

GENUS II. SULPHURETS OF ANTIMONY.

SPECIES 1. Grey ore of antimony *.

This ore, which is the moſt common, and indeed almoſt the only ore of antimony, occurs both maſſive, diſſeminated, and cryſtallized. Its cryſtals are four-ſided priſms, ſomewhat flattened, whoſe ſides are nearly rectangles, terminated by ſhort four-ſided pyramids, whoſe ſides are trapeziums †. Sometimes two of the edges are wanting, which renders the priſm ſix-ſided ‡.

Colour grey. Luſtre metallic. Streak grey, metallic, and brighter. Powder black or greyiſh black. Hardneſs 6 to 7. Sp. gr. from 4.1327 to 4.516 §. Often ſtains the fingers. Before the blow-pipe melts eaſily, burns with a blue flame, and depoſits a white oxide on the charcoal. When placed in an open veſſel, over a ſlow fire, the ſulphur evaporates, and leaves a grey oxide of antimony. This oxide, if fuſed with tartar, is reduced.

This ore, when taken out of the mine, almoſt always contains a large proportion of quartz or other ſtony matter. When pure, it is compoſed of about Metallic Ores.

74 antimony,
26 ſulphur.

100

Werner has divided this ſpecies into three varieties.

Variety 1. Compact ſulphuret.

Colour bluiſh grey, ſurface often tarniſhed, and then it is blue or purpliſh. Luſtre 1 to 2. Texture compact. Fracture fine grained, uneven. Powder black, dull, and earthy. Slightly ſtains the fingers.

Variety 2. Foliated ſulphuret.

Colour light ſteel grey. Luſtre 3 to 4. Texture foliated. Powder as that of the laſt variety.

Variety 3. Striated ſulphuret.

Colour dark ſteel grey, and light bluiſh grey, ſurface often tarniſhed, and then it is dark blue or purpliſh. Luſtre 3 to 2. Texture ſtriated. Powder greyiſh black. This variety alone has been hitherto found cryſtallized.

250 Plumoſe antimonial ore. † Kirw. ii. 250.

SPECIES 2. Plumoſe antimonial ore †.

Sulphurets of antimony and arſenic.

This ſpecies, which is ſometimes found mixed with the cryſtals of ſulphurated antimony, is in the form of brittle, capillary, or lanuginous cryſtals, often ſo ſmall that they cannot be diſtinctly ſeen without a microſcope.

Colour ſteel or bluiſh grey, often tarniſhed, and then brown or greyiſh black. Luſtre 1, ſemimetallic. Before the blow-pipe emits a ſmoke, which depoſits a whitiſh and yellowiſh powder on the charcoal: it then melts into a black ſlag.

It is ſuppoſed to conſiſt of ſulphur, antimony, arſenic, and ſome ſilver.

251 Red antimonial ore. † Kirw. ii. 250.

SPECIES 3. Red antimonial ore †.

Hydroſulphuret of antimony.

This ſpecies is generally found in cavities of ſulphurated antimonial ore. It is cryſtallized in delicate needles, often diverging from a common centre.

Colour red. Luſtre 2, ſilky. Sp. gr. 4.7. Before the blow-pipe melts eaſily, and evaporates with a ſulphureous ſmell.

This ore has not been analyſed. Mineralogiſts have ſuppoſed it to be a natural kermes. If ſo, we may conclude, from the experiments of Berthollet *, that it is a hydroſulphuret of antimony, and conſequently compoſed of oxide of antimony, ſulphur, and ſulphurated hydrogen gas. * Ann. de Chim. xxv. 259.

252 G. III. Oxides of antimony.

GENUS III. OXIDES OF ANTIMONY.

There is a ſubſtance found incumbent on ſulphuret of antimony, of a yellow colour, and an earthy appearance, which has been ſuppoſed an oxide of antimony, and denominated antimonial ochre. But hitherto it has not been analyſed.

GENUS

(o) The word *gang* is uſed by German mineralogiſts to denote a metallic vein. Now, it is not often that theſe veins conſiſt entirely of *ore*; in general, they contain ſtony matter beſides. For inſtance, in the copper mine at Airthry, near Stirling, the copper ore is merely a narrow ſtripe in the middle of the vein, and the reſt of it is filled up with ſulphat of barytes. We uſe the word *gangue* (as the French do), to denote, not the *metallic* vein, but the *ſtony* matter which accompanies the ore in the vein. The gangue of the copper ore at Airthry is ſulphat of barytes.

Ores of Bismuth.

GENUS IV. SALTS OF ANTIMONY.

SPECIES I. Muriat of antimony*.

253 G. IV. Salts. Muriat of antimony.

This ore, which has been found in Bohemia, is sometimes in quadrangular tables; sometimes in acicular cryſtals grouped like zeolites; and ſometimes in priſms.

Colour pale yellowiſh or greyiſh white. Luſtre 3 to 1, nearly metallic. Tranſparency 2. Texture foliated. Melts eaſily by the flame of a candle, and emits a white vapour †. Before the blow-pipe decrepitates; when powdered, and juſt ready to melt, it evaporates, and leaves a white powder around. Between two pieces of coal it is reducible to a metallic ſtate.

* Kirw. ii. 251.
† Hauy, Jour. de Min. Nº xxxii. 609.

ORDER XI. ORES OF BISMUTH*.

BISMUTH is employed in the manufacture of pewter, of printers types, in ſoldering; and perhaps alſo its property of rendering other metals more fuſible, might make it uſeful in anatomical injections. The quantity conſumed in commerce is not great.

It has been found only in the primitive mountains, and is by no means common. When unaccompanied by any other metal, it does not form veins, but kidney-form maſſes. It often accompanies cobalt. Its gangue is commonly quartz. Its ores are not very abundant. They have been found chiefly in Sweden, Norway, Tranſylvania, Germany, France, and England.

* Pott, Obſerv. Chym. 134—Geoffroy, Mem. Par. 1753, p. 296.

GENUS I. ALLOYS OF BISMUTH.

SPECIES I. Native biſmuth *.

254 G. I. Alloys. Native biſmuth.

This mineral, which is found at Schneeberg, Johangeorgenſtadt, &c. in Germany, has commonly the form of ſmall plates lying above one another. Sometimes it is cryſtallized in four-ſided tables, or indiſtinct cubes.

Colour white with a ſhade of red; ſurface often tarniſhed red, yellow, or purple. Luſtre metallic, 3 to 2. Opaque. Texture foliated or ſtriated. Hardneſs 6. Sp. gr. 9.022 † to 9.57 ‡. Exceedingly fuſible. Before the blow-pipe gives a ſilvery white bead, and at laſt evaporates in a yellowiſh white ſmoke, which is depoſited on the charcoal.

It is generally accompanied by cobalt, and ſometimes contains arſenic.

* Kirw. ii. 264.
† Briſſon.
‡ Kirwan.

GENUS II. SULPHURETS OF BISMUTH.

SPECIES I. Common ſulphuret of biſmuth *.

255 G. II. Sulphurets. Common ſulphuret of biſmuth.

This ore, which is found in Sweden, Saxony, and Bohemia, occurs ſometimes in amorphous maſſes, and ſometimes in needleform cryſtals.

Colour commonly bluiſh grey, ſometimes white; ſurface often tarniſhed yellow, red, and purple. Powder black and ſhining. Luſtre metallic, 2 to 3. Streak obſcurely metallic. Texture foliated. Hardneſs 5. Brittle. Sp. gr. 6.131 † to 6.4672 ‡. When held to the flame of a candle, it melts with a blue flame and ſulphureous ſmell. Before the blow-pipe emits a reddiſh yellow ſmoke, which adheres to the charcoal. This powder becomes white when it cools, and reſumes its former colour when the flame is directed upon it *.

This ore, according to Sage, contains 60 biſmuth.
And, according to La Perouſe, it holds 36 ſulphur.

———
99

* Kirw. ii. 266.—Sage, Mem. Par. 1782, 307.
† Kirwan.
‡ Briſſon.
* Gillot, Jour. de Min. Nº xxxii. 585.

A ſpecimen, analyſed by Klaproth, contained
95 biſmuth,
5 ſulphur.
———
100 †

It is commonly accompanied by quartz, aſbeſtos, or ſparry iron ore.

† Beiträge, i. 256.

GENUS III. OXIDES OF BISMUTH.

SPECIES I. Yellow oxide of biſmuth ‡.

Biſmuth ochre.

256 G. III. Oxides. Yellow oxide of biſmuth.

This ore generally accompanies the two ſpecies already deſcribed. It is found in two ſtates; either of an earthy conſiſtence, or cryſtallized in cubes or quadrangular plates.

Colour uſually greeniſh yellow, ſometimes grey. Soluble in nitrous acid without efferveſcence, and may in a great meaſure be precipitated by the effuſion of water.

‡ Kirw. ii. 263.

ORDER XII. ORES OF ARSENIC.

ARSENIC is uſed as an alloy for ſeveral other metals, eſpecially copper. It is ſometimes employed to facilitate the fuſion of glaſs, or to render it opaque, in order to form an enamel. Preparations of arſenic are employed as paints; and, like moſt other violent poiſons, it has been introduced into medicine.

This metal is ſcattered in great abundance over the mineral kingdom, accompanying almoſt every other metal, and forming alſo ſometimes peculiar veins of its own. Of courſe it occurs in almoſt every ſpecies of mountain, and is accompanied by a variety of gangues.

GENUS I. ALLOYS OF ARSENIC.

SPECIES I. Native arſenic †.

257 G. I. Alloys. Native arſenic.

This mineral is found in different parts of Germany. It occurs generally in maſſes of various ſhapes, kidney-form, botryoidal, &c.

Colour that of ſteel. Its ſurface quickly becomes tarniſhed by expoſure to the air. Luſtre metallic (when freſh), 2 to 3. Streak bluiſh grey, metallic, and bright. Powder dull and black. Texture compact. Hardneſs 7 to 8. Brittle. Sp. gr. 5.67 † to 5.7249 ‡. Gives an arſenical ſmell when ſtruck. Before the blow-pipe emits a white ſmoke, diffuſes a garlic ſmell, burns with a blue flame, gradually evaporates, depoſiting a white powder.

It is always alloyed with ſome iron §, and often contains ſilver, and ſometimes gold.

† Kirw. ii. 255.
† Kirwan.
‡ Briſſon.
§ De Born. Catal of M. Raab. ii. 194.

GENUS II. SULPHURETS OF ARSENIC.

SPECIES I. Orpiment (P).

Auripigmentum.

258 G. II. Sulphurets. Orpiment.

This ore, which is found in Hungary, Wallachia, Georgia, and Turkey in Aſia, is either maſſive or cryſtallized. The cryſtals are confuſed, and their figure cannot be eaſily determined; ſome of them appear octohedrons, and others minute four-ſided priſms.

Its colour is yellow. Streak orange yellow. Luſtre waxy, 2 to 3. Tranſparency from 0 to 2. Texture foliated. Hardneſs 4 to 8. Sp. gr. from 3.048 * to 3.521 †. Effervesces with hot nitric acid. Burns with

* Kirwan.
† Gillert.

a

(P) Kirw. II. 260.—*Alberti de Auripigmento.—Scopoli in Anno 5to Hiſt. Naturali*, p. 59.—*Berg.* II. 297.

Ores of Arfeniat. a bluifh white flame. Before the blow-pipe melts, fmokes, and evaporates, leaving only a little earth and fome traces of iron.

Compofed of	80 fulphur,
	20 arfenic.
	100

259 Realgar. SPECIES 2. Realgar *.

* Kirw. ii. 261.—Berg. ii. 297.

This mineral is found in Sicily, about Mount Vefuvius, in Hungary, Tranfylvania, and various parts of Germany. It is either maffive or cryftallized. The primitive form of the cryftals is, according to Romé de Lifle, a four-fided rhomboidal prifm, terminated by four-fided pyramids, the fides of which are rhombs †. It commonly appears in 4, 6, 8, 10, or 12 fided prifms, terminated by four-fided fummits ‡.

† Cryftal. iii. 34.

‡ Ibid.

Colour red. Streak yellowifh red. Powder fcarlet. Luftre 3 to 2. Tranfparency from 2 to 3; fometimes 0. Hardnefs 5 to 6. Sp. gr. 3.3384 §. It is an electric *per fe*, and becomes negatively electric by friction ‖. Nitric acid deprives it of its colour. Before the blow-pipe it melts eafily, burns with a blue flame and garlic fmell, and foon evaporates.

§ Briffon.

‖ Hauy, Jour. de Min. N° xxxii. 612.

Compofed of	20 fulphur,
	80 arfenic.
	100

260 G. III. Oxides. White oxide of arfenic.

GENUS III. OXIDES OF ARSENIC.

SPECIES 1. White oxide of arfenic *.

Native calx of arfenic.

* Kirw. ii. 258—Berg. ii. 285.

This ore is found in various parts of Germany, Hungary, &c. either in powder, or maffive, or cryftallized in prifmatic needles.

Colour white or grey, often with a tint of red, yellow, green, or black. Luftre common, 1 to 2. Tranfparency 1 to 0; when cryftallized, 2. Texture earthy. Hardnefs 6. Brittle. Sp. gr. 3.7 †. Soluble in hot diluted nitric acid without effervefcence. Soluble at 60° Fahrenheit in 80 times its weight of water. Before the blow-pipe fublimes, but does not inflame. Tinges borax yellow.

† Kirwan.

ORDER XIII. COBALT ORES.

COBALT is employed to tinge glafs of a blue colour, and is ufeful in painting upon porcelain.

Cobalt ores are found almoft exclufively in the ftratified mountains, except one fpecies, fulphuret of cobalt, which affects the primitive mountains. They are not very abundant; and for that reafon cobalt is more valuable than many of the other metals which have been already treated of. They are commonly accompanied by nickel, bifmuth, or iron. They are moft abundant in Germany, Sweden, Norway, and Hungary; they have been found alfo in Britain and France, but not in any great quantity.

261 G. I. Alloys. Cobalt alloyed with arfenic.

GENUS I. ALLOYS OF COBALT.

SPECIES 1. Cobalt alloyed with arfenic †.

Dull grey cobalt ore.

† Kirw. ii. 270.

This ore, which occurs in different parts of Germany, is either amorphous or cryftallized. The forms of its cryftals are the cube; fometimes the cube with its angles, or edges, or both wanting; and the octahedron ‡.

‡ Romé de Lifle, iii. 123.

Metallic Ores.

Its colour, when frefh broken, is whitifh or bluifh grey, fometimes with a fhade of red; when expofed to the air it foon becomes tarnifhed. Streak bluifh grey and metallic. Luftre fcarcely metallic, 0 to 1. Texture compact. Hardnefs 10. Difficultly frangible. Sp. gr. when amorphous, 5.309 to 5.571 §; when cryftallized 7.7207 †. When ftruck it gives out an arfenical fmell. Before the blow-pipe it gives out an arfenical vapour, becomes magnetic, and melts eafily, unlefs it contains a great quantity of iron. Tinges borax dark blue, and a fmall metallic bead is obtained.

§ Kirw. ii. 270.

† Hauy, Jour. de Min. N° xxxii. 588.

A fpecimen of this ore from Cornwall, examined by Mr Klaproth, contained

	20 cobalt,
	24 iron,
	33 arfenic.
	77

with fome bifmuth and ftony matter *.

*Klaproth's Cornwall, p. 61.

Another fpecimen from Tunaberg, according to the analyfis of the fame chemift, contained

	55.5 arfenic,
	44.0 cobalt,
	.5 fulphur.
	100 †

† Beiträge, ii. 307.

262 G. II. Sulphurets. White cobalt ore.

GENUS II. SULPHURETS OF COBALT.

SPECIES 1. White cobalt ore ‡.

Sulphuret of cobalt, arfenic, and iron.

‡ Kirw. ii. 273.—Sage, Jour. de Phy. xxxix. 53.

The defcriptions which different mineralogifts have given of this ore are fo various, that it is impoffible not to fuppofe that diftinct fubftances have been confounded together.

It occurs either in maffes, or cryftallized in cubes, dodecahedrons, octohedrons, and icofahedrons.

Colour tin white, fometimes tarnifhed reddifh or yellowifh. Powder fteel grey. Luftre partly metallic, and from 2 to 4; partly 0 or 1. Texture foliated. Hardnefs 8 to 9. Sp. gr. from 6.284 † to 6,4509 ‡. Before the blow-pipe generally gives out an arfenical vapour, and does not melt.

† Kirwan.

‡ Hauy.

The analyfes that have been given of this ore are very various. Sometimes it has been found to contain no arfenic nor iron, and fometimes to contain both. A fpecimen from Tunaberg in Sweden, which ought to belong to this fpecies, was analyfed by Taffaert, and found to confift of

	49 arfenic,
	36.6 cobalt,
	5.6 iron,
	6.5 fulphur.
	97.7 †

† Ann. de Chim. xxviii. 100.

Klaproth found a fpecimen of the fame ore to contain

	55.5 arfenic,
	44.0 cobalt,
	0.5 fulphur.
	100.0 ‡

‡ Beiträge, ii. 307.

263 G. III. Oxides. Black cobalt ore or ochre.

GENUS III. OXIDES OF COBALT.

SPECIES 1. Black cobalt ore or ochre §.

This ore, which occurs in different parts of Germany, is either in the form of powder, or indurated.

Colour black, often with a fhade of blue, grey, brown, or green. Luftre 0 to 1. Streak brighter. Hardnefs (of the indurated) from 4 to 8. Sp. gr. 3 to 4. Soluble in muriatic acid. Tinges borax blue.

§ Kirw. ii. 275.

SPECIES

294 Brown cobalt ore. * Kirwan, ii. 276.

SPECIES 2. Brown cobalt ore *.

Colour greyiſh or dark leather brown. Streak brighter, unctuous. Communicates a pale blue tinge in fuſion.

265 Yellow cobalt ore. † Ibid.

SPECIES 3. Yellow cobalt ore †.

Colour yellow. Dull and earthy. Hardneſs 4 to 5. Texture earthy. Streak brighter, unctuous. Gives a weak blue tinge.

266 G. IV. Salts. Arſeniat of cobalt. ‡ Id. 278.

GENUS IV. SALTS OF COBALT.

SPECIES 1. Arſeniat of cobalt ‡.

Red cobalt ore.

This ſpecies, like moſt other ores of cobalt, has neither been accurately deſcribed nor analyſed.

It is found in maſſes of various ſhapes, and cryſtallized in quadrangular tables or acicular priſms.

Colour red. Luſtre from 2 to 3, ſometimes 0. Tranſparency 0 to 2. Hardneſs 5 to 7. Brittle. Before the blow-pipe becomes blackiſh grey. Diffuſes a weak arſenical ſmell. Tinges borax blue.

ORDER XIV. ORES OF NICKEL.

HITHERTO nickel has been found in too ſmall quantities to be applied to any uſe; of courſe there are, properly ſpeaking, no mines of nickel. It occurs only (as far as is yet known) in the ſecondary mountains, and it commonly accompanies cobalt. It has been found in different parts of Germany, in Sweden, Siberia, Spain, France, and Britain.

267 G. I. Sulphurets. Sulphuret of nickel with arſenic and iron. * Ibid. 286. ‡ Briſſon.

GENUS I. SULPHURETS OF NICKEL.

SPECIES 1. Sulphuret of nickel with arſenic and iron.

*Kupfer nickel**.

This, which is the moſt common ore of nickel, occurs either maſſive or diſſeminated, but never cryſtallized.

Colour often that of copper, ſometimes yellowiſh white or grey. Recent fracture often ſilver white. Luſtre metallic, 2 to 3. Texture compact. Hardneſs 8. Sp. gr. 6.6086 to 6.6481 ‡. Soluble in nitric and nitro-muriatic acids. Solution green. Before the blow-pipe exhales an arſenical ſmoke, and melts into a bead which darkens by expoſure to the air.

It is compoſed of various proportions of nickel, arſenic, iron, cobalt, ſulphur; often contains biſmuth, and ſometimes ſilver and copper.

268 G. II. Oxides. Nickel ochre. * Kirwan, ii. 284.

GENUS II. OXIDES OF NICKEL.

SPECIES 1. Nickel ochre *.

This mineral occurs either in the form of a powder, or indurated, and then is either amorphous, or cryſtallized in acicular form cryſtals. The powder is generally found on the ſurface of other nickel ores.

Colour different ſhades of green. Luſtre 1 to 0. Texture earthy. Sp. gr. conſiderable. Slowly diſſolves in acids: ſolution green. Before the blow-pipe does not melt; but gives a yellowiſh or reddiſh brown tinge to borax.

This ore often contains ſulphat of nickel, which is ſoluble in water. The ſolution, when evaporated, gives oblong rhomboidal cryſtals, from which alkalies precipitate a greyiſh green oxide. This oxide is ſoluble by acids and by ammonia. The acid ſolution is green; the alkaline blue.

269 G. III. Salts. Arſeniat of nickel. † Kirwan, ii. 285.

GENUS III. SALTS OF NICKEL.

SPECIES 1. Arſeniat of nickel †.

This ore, which was lately diſcovered at Regendorff by Mr Gmelin, is found in ſhapeleſs maſſes, and is often mixed with plates of ſulphat of barytes.

Colour pale grey, here and there mixed with pale green. Streak white. Luſtre 0. Texture compact. Hardneſs 7. Difficultly frangible. Sp. gr. conſiderable. Adheres ſlightly to the tongue, and gives an earthy ſmell when breathed on. Soluble in hot nitric and muriatic acids: ſolution green.

Contains ſome cobalt and alumina.

ORDER XV. ORES OF MANGANESE (q).

HITHERTO manganeſe, in its metallic ſtate, has ſcarcely been put to any uſe; but under the form of an oxide it has become of great importance. The oxide of manganeſe has the property of rendering colourleſs a variety of bodies which injure the tranſparency of glaſs; and it has been long uſed in glaſs manufactories for this purpoſe under the name of *glaſs ſoap*. By means of the ſame oxide, oxy-muriatic acid is prepared, which has rendered manganeſe of great importance in bleaching. Not to mention the utility of manganeſe to the chemiſt, the property which it has of facilitating the oxidation of other metals, and of rendering iron more fuſible—will probably make it, in no very remote period, of very conſiderable importance in numerous manufactories.

Ores of manganeſe occur often in ſtrata, both in the primitive and ſecondary mountains; ſcarcely ever, however, we believe, in thoſe mountains which are conſidered as the moſt ancient of all. They are very common, having been found abundantly in Germany, France, Spain, Britain, Sweden, Norway, Siberia, and other countries.

GENUS I. OXIDES OF MANGANESE. 270 G. I. Oxides.

Hitherto manganeſe has only been found in the ſtate of oxide. La Perouſe, indeed, ſuſpected that he had found it in a metallic ſtate: but probably there was ſome miſtake or other in his obſervations.

SPECIES 1. Oxide of manganeſe combined with barytes. 271 Oxide of manganeſe combined with barytes.

This ſpecies, which exiſts in great abundance in Romaneche near the river Soane in France, is found maſſive, forming a ſtratum in ſome places more than 12 feet thick.

Colour greyiſh black or browniſh black, of great intenſity. Luſtre, external, 0; internal, metallic, 1. Soon tarniſhes by expoſure to the air, and then becomes intenſely black. Texture granular. Fracture uneven; ſometimes conchoidal. Often porous. Hardneſs 11. Difficultly frangible. Sp. gr. from 3.950 to 4.10. Abſorbs water. When taken out of water after a minute's immerſion it has a ſtrong argillaceous ſmell. Conducts electricity nearly as well as if it were in a metallic ſtate. Infuſible by the blow-pipe. Tinges ſoda red; the colour diſappears before the blue cone of flame, and is reproduced by the action of the yellow flame.

From

(q) *Pott. Miſcelan. Berolens*, VI. 40.—*Margraff, Mem. Berlin*, 1773, p. 3.—*La Perouſe, Jour. de Phyſ.* XVI. 156. and XV. 67. and XXVIII. 68.—*Sage, Mem. Par.* 1785, 235.

Ores of Manganese.

From the analysis of Vauquelin, it appears that it is composed of

50.0	white oxide of manganese,
33.7	oxygen,
14.7	barytes,
1.2	silica,
.4	charcoal.
100.0 ¶	

¶ Dolomieu, Jour. de Min. N° xix 42.

272 Grey ore of manganese.

SPECIES 2. Grey ore of manganese *.

This ore occurs both massive and disseminated: it is also sometimes crystallized in slender four-sided prisms or needles.

* Kirwan, ii. 291.

Colour usually dusky steel grey; sometimes whitish grey, or reddish grey. Streak and powder black. External lustre 3 to 2; internal metallic, 2 to 1. Texture striated or foliated. Hardness 4 to 5. Brittle. Sp. gr. from 4.073 † to 4.8165 ‡. Before the blow-pipe darkens. Tinges borax reddish brown.

† Vauquelin. ‡ Brisson.

A specimen of oxide of manganese from the mountains of Vosges, which probably belonged to this species, and which was analysed by Vauquelin, was composed of

82	oxide of manganese,
7	carbonat of lime,
6	silica,
5	water.
100 §	

§ Jour. de Min. N° xvii. 13.

Sometimes it contains a little barytes and iron.

273 Black or brown ore of manganese.

SPECIES 3. Black or brown ore of manganese *.

This ore is found sometimes in the state of powder, and sometimes indurated in amorphous masses of various figures. Colour either black, sometimes with a shade of blue or brown; or reddish brown. Streak of the harder sorts metallic; of the others, black. Lustre 0 to 1; internal (when it is indurated), metallic. Texture compact. Hardness 5 to 7. Sp. gr. 3.7076 to 3.9039; that of the powdery sometimes only 2. Before the blow-pipe it exhibits the same phenomena as the last species.

* Kirwan, ii. 292.—Wedgewood, Phil. Trans. lxxiii. 284.

A specimen of this ore, analysed by Westrum, contained

45.00	manganese,
14.00	oxide of iron,
11.00	silica,
7.25	alumina,
2.00	lime,
1.50	oxide of copper,
18.00	air and water.
98.75	

274 G. II. Salts. Carbonat of manganese.

GENUS II. SALTS OF MANGANESE.

SPECIES 1. Carbonat of manganese †.

White ore of manganese.

This species occurs in Sweden, Norway, and Transylvania. It is either in the form of loose scales, or massive, or crystallized in needles.

† Kirwan, ii. 297.

Colour white, or reddish white. Texture either radiated or scaly. Lustre of the scaly 2. Transparency 1 to 2. Hardness of the massive 6 to 9. Sp. gr. 2.794. Effervesces with mineral acids. Heated to redness, blackens. Tinges borax violet.

Metallic Ores.

275 Red ore of manganese.

SPECIES 2. Red ore of manganese †.

Carbonat of manganese and iron.

This species has been found in Piedmont and in the Pyrenees: It is sometimes in powder, sometimes massive, sometimes crystallized in rhomboidal prisms or needles.

† Kirwan, ii. 297.—Napion, Mem. Turin, iv. 303.

Colour pale rosy red, mixed with white. Powder nearly white. Lustre 0. Transparency 1. Hardness 8. Sp. gr. 3.233. Effervesces with nitric and muriatic acids. When heated to redness becomes reddish brown. Tinges borax red.

A specimen, analysed by Ruprecht, contained

55.0	silica,
25.0	oxide of manganese,
7.0	oxide of iron,
1.5	alumina.
98.5 §	

§ Jour de Phys. xxxi. 22.

ORDER XVI. ORES OF TUNGSTEN.

As no easy method has hitherto been discovered of reducing tungsten to a metallic state, we need not be surprised that it has been applied to no use. Ores of tungsten are by no means common. They have hitherto been found only in the primitive mountains. Their gangue is commonly quartz. They very often accompany tin ores.

276 G. I. Oxides. Wolfram.

GENUS I. OXIDES OF TUNGSTEN.

SPECIES 1. Wolfram (R).

Oxides of tungsten, iron, and *manganese—Tungstat of iron* and *manganese.*

This species is found in different parts of Germany, in Sweden, Britain, France and Spain; and is almost constantly accompanied by ores of tin. It occurs both massive and crystallized. The primitive form of its crystals, according to the observations of Mr Hauy, is a rectangular parallelopiped ‡, whose length is 8.66, whose breadth is 5, and thickness 4.33 *. It is not common, however, to find crystals of this perfect form; in many cases, the angles, and sometimes the edges, of the crystal are wanting †; owing, as Mr Hauy has shewn, to the superposition of plates, whose edges or angles decrease according to a certain law ‡.

‡ Fig. 42. * Jour. de Min. N° xix. 8. † Fig. 43. ‡ Jour. de Min. N° xix. 8.

Colour brown or brownish black. Streak reddish brown. Powder stains paper with the same colour. Lustre external, 2; internal, 2 to 3; nearly metallic. Texture foliated. Easily separated into plates by percussion. Hardness 6 to 8. Sp. gr. from 7.006 * to 7.333 †. Moderately electric by communication. Not magnetic. Infusible by the blow-pipe. Forms with borax a greenish globule, and with microcosmic salt a transparent globule of a deep red ¶.

* Kirwan. † Hauy. ¶ Vauquelin, Jour. de Min. N° xix. 11.

The specimen of this ore, examined by Messrs d'Elhuyart's, was composed of

65	oxide of tungsten,
22	oxide of manganese,
13	oxide of iron.
100	

Another

(R) *Kirw.* II. 316.—*De Luyart, Mem. Thoulouse,* II. 141.—*Gmelin, Crell's Jour.* English Trans. III. 127, 205, and 293.—*La Perouse, Jour. de Min.* N° IV. p. 23.

Ores of Molybdenum.

Another ſpecimen from Pays le Mines in France, analyſed by Vauquelin and Hecht, contained

67.00	oxide of tungſten,
18.00	black oxide of iron,
6.25	black oxide of mangaueſe,
1.50	ſilica,
7.25	oxide of the iron and manganeſe.
100.00 §	

§ *Vauquelin, Jour. de Min.* N° xix. 11.

Genus II. salts of tungsten.

277 G. II. Salts. Tungſtat of lime.

Species 1. Tungſtat of lime (s).

Tungsten.

This ore, which is now exceedingly ſcarce, has hitherto been found only in Sweden and Germany. It is either maſſive or cryſtallized; and, according to Hauy, the primitive form of its cryſtals is the octahedron †.

† *Jour. de Min.* N° xxxiii. 657.

Colour yellowiſh white or grey. Luſtre 3 to 2. Tranſparency 2 to 3. Texture foliated. Hardneſs 6 to 9. Sp. gr. 5.8 to 6.0665. Becomes yellow when digeſted with nitric or muriatic acids. Infuſible by the blow-pipe. With borax forms a colourleſs glaſs, unleſs the borax exceed, and then it is brown. With microcoſmic ſalt it forms a blue glaſs, which loſes its colour by the yellow flame, but recovers it in the blue flame ‡.

‡ *Scheele* and *Bergman.*

It is compoſed of about 70 oxide of tungſten,
30 lime.
100
with a little ſilica and iron §.

§ *Scheele.*

278 Brown tungſtat.

Species 2. Brown Tungſtat.

This ore is found in Cornwall, and is either maſſive or compoſed of ſmall cryſtalline grains.

Colour grey, variegated with yellow and brown. Luſtre 2, waxy. Hardneſs 6 to 7. Sp. gr. 5.57. Its powder becomes yellow when digeſted in aqua regia.

According to Klaproth, it is compoſed of

88.0	oxide of tungſten,
11.5	lime.
99.5	

Order XVII. ORES OF MOLYBDENUM.

If ever molybdenum be found in abundance, it will probably be uſeful in dyeing and painting. At preſent it is very ſcarce, having only been found in Sweden, Germany, Carniola, and among the Alpes. Like tin and tungſten, it affects the primitive mountains.

279 G. I. Sulphuret. Common ſulphuret.

Genus I. sulphuret of molybdenum.

Species 1. Common ſulphuret (t).

Molybdena.

This ore, which is the only ſpecies of molybdenum ore at preſent known, is found commonly maſſive; ſometimes, however, it is cryſtallized in hexahedral tables.

Colour light lead grey; ſometimes with a ſhade of red. Streak bluiſh grey, metallic. Powder bluiſh. Luſtre metallic, 3 to 2. Texture foliated. Lamellæ ſlightly flexible. Hardneſs 4. Sp. gr. 4.569 * to 4.7385 †. Feels greaſy; ſtains the fingers. Marks bluiſh black. A piece of reſin rubbed with this mineral becomes poſitively electric ‡. Inſoluble in ſulphuric and muriatic acids; but in a boiling heat colours them green. Effervefces with warm nitric acid, leaving a grey oxide undiſſolved. Before the blow-pipe, on a ſilver ſpoon, emits a white ſmoke, which condenſes into a white powder, which becomes blue in the internal, and loſes its colour in the external, flame. Scarcely affected by borax or microcoſmic ſalt. Effervefces with ſoda, and gives it a reddiſh pearl colour.

* *Karſten.*
† *Briſſon.*

Metallic Ores.

‡ *Hauy, Jour. de Min.* N° xix. 70.

Compoſed of about 60 molybdenum,
40 ſulphur.
100 *

* *Klaproth.*

Order XVIII. ORES OF URANIUM.

Uranium has hitherto been found only in Germany, and has not been applied to any uſe. The only two mines where it has occurred are in the primitive mountains.

280 G. I. Oxides. Sulphuret of uranium.

Genus I. oxides of uranium.

Species 1. Sulphuret of uranium †.

Pechblende.

This ore, which has been found at Johanngeorgenſtadt in Saxony, and Joachimſthal in Bohemia, is either maſſive or ſtratified with other minerals.

† *Kirwan*, ii. 305.

Colour black or browniſh black; ſometimes with a ſhade of grey or blue. Streak darker. Powder opaque and black. Luſtre ſemimetallic, from 3 to 1. Fracture conchoidal. Hardneſs 7 to 8. Very brittle. Sp. gr. from 6.3785 ‡ to 7.5, and even higher §. Imperfectly ſoluble in ſulphuric and muriatic acids; perfectly in nitric acid and aqua regia. Solution wine yellow. Infuſible with alkalies in a crucible: infuſible by the blow-pipe *per ſe*. With borax and ſoda forms a grey opaque ſlag; with microcoſmic ſalt, a green glaſs.

‡ *Morveau, Jour. de Min.* N° xxxii. 610.
§ *Klaproth, Beiträge*, ii. 197.

Compoſed of oxide of uranium and ſulphur, and mixed with iron and ſilica, and ſometimes lead.

A ſpecimen of this ore from Joachimſthal, analyſed lately by Klaproth, contained

86.5	uranium,
6.0	ſulphuret of lead,
5.0	ſilica,
2.5	oxide of iron.
100.0 *	

* *Beiträge*, ii. 221.

281 Yellow oxide of uranium.

Species 2. Yellow oxide of uranium ‡.

Uranitic ochre.

This ore is generally found on the ſurface of the laſt ſpecies at Johanngeorgenſtadt, and is either maſſive or in powder.

‡ *Kirwan*, ii. 303.

Colour yellow, red, or brown. Streak of the yellow ſorts yellow; of the red, orange yellow. Luſtre 0. Slightly ſtains the fingers. Feels meagre. Texture earthy. Hardneſs 3 to 4. Sp. gr. 3.2438 ‖. Infuſible by the blow-pipe; but in a ſtrong heat becomes browniſh grey.

‖ *Hauy, Jour. de Min. ibid.*

Compoſed of oxide of uranium and oxide of iron.

(s) *Kirw.* II. 314.—*Scheele's Works* (French tranſlation), II. 81.—*Bergman, ibid.* p. 94.—*Crell, Chem. Annalen.* 1784, 2 Band 195.

(t) *Kirw.* II. 322.—*Scheele's Works* (French tranſlation), I. 236.—*Pelletier, Jour. de Phyſ.* XXVII. 434.—*Ilſemann, ibid.* XXXIII. 292.—*Sage, ibid.* 389.—*Klaproth* and *Modeer, Ann. de Chim.* III. 120.

Ores of Titanium.

282 G. II. Salts Carbonat of uranium

¶ *Kirwan*, ii. 304.
§ *Gmelin*.

GENUS II. SALTS OF URANIUM.

SPECIES 1. Carbonat of uranium ¶.

This ſubſtance is alſo found at Johanngeorgenſtadt, and near Eibenſtock and Rheinbreidenbach §. It is ſometimes amorphous, but more commonly cryſtallized. Its cryſtals are ſquare plates, octahedrons, and ſix ſided priſms.

Colour green; ſometimes nearly white; ſometimes, though rarely, yellow. Streak greeniſh white. Luſtre 3 to 2; internal, 2; ſometimes pearly; ſometimes nearly metallic. Tranſparency 2 to 3. Texture foliated. Hardneſs 5 to 6. Brittle. Soluble in nitric acid without efferveſcence. Infuſible by alkalies.

Compoſed of carbonat of uranium, with ſome oxide of copper. When its colour is yellow it contains no copper.

ORDER XIX. ORES OF TITANIUM.

* *Jour. de Min.* N° xv. 27.
† *Ibid.* N° xii. 51.
‡ *Jour. de Min.* N° xxxii. 614.
‖ *Ibid.*

TITANIUM has been known for ſo ſhort a time, and its properties are yet ſo imperfectly aſcertained, that many of its uſes muſt remain to be diſcovered. Its oxide, as we learn from Mr Darcet, has been employed in painting on porcelain *. Hitherto it has been found only in the primitive mountains, the Crapacks †, the Alpes (u), and the Pyrenees ‡. It has been found alſo in Brittany ‖ and in Cornwal.

283 G. I. Oxides. Red oxide of titanium.

GENUS I. OXIDES OF TITANIUM.

SPECIES 1. Red oxide of Titanium.

Red ſhorl—Sagenite.

This ore has been found in Hungary, the Pyrenees, the Alpes, and in Brittany in France. It is generally cryſtallized. The primitive form of its cryſtals, according to the obſervations of Mr Hauy, is a rectangular priſm, whoſe baſe is a ſquare; and the form of its molecules is a triangular priſm, whoſe baſe is a right angled iſoſceles triangle, and the height is to any of the ſides of the baſe about the right angle as $\sqrt{12}$ to $\sqrt{5}$, or nearly as 3 : 2 ¶. Sometimes the cryſtals of titanium are ſix-ſided, and ſometimes four-ſided, priſms, and often they are implicated together ‡.

¶ *Jour. de Min.* N° xv. 28. and xxxii. 615.
‡ Fig. 44.

Colour red or browniſh red. Powder brick or orange red. Luſtre 3. Tranſparency commonly 0; ſometimes 1. Texture foliated. Hardneſs 9. Brittle. Sp. gr. from 4.18 * to 4.2469 †. Not affected by the mineral acids. When fuſed with carbonat of potaſs, and diluted with water, a white powder precipitates, heavier than the titanium employed. Before the blow-pipe it does not melt, but becomes opaque and brown. With microcoſmic ſalt it forms a globule of glaſs, which appears black; but its fragments are violet. With borax it forms a deep yellow glaſs, with a tint of brown. With ſoda it divides and mixes, but does not form a tranſparent glaſs.

* *Klaproth.*
† *Vauquelin* and *Hecht*.

When pure, it is compoſed entirely of oxide of titanium.

284 Menachanite.

SPECIES 2. Menachanite (x).

Oxide of titanium combined with iron.

This ſubſtance has been found abundantly in the valley of Menachan in Cornwal; and hence was called menachanite by Mr Gregor, the diſcoverer of it. It is in ſmall grains, like gunpowder, of no determinate ſhape, and mixed with a fine grey ſand. Colour black. Eaſily pulverized. Powder attracted by the magnet. Sp. gr. 4.427. Does not detonate with nitre. With two parts of fixed alkali it melts into an olive coloured maſs, from which nitric acid precipitates a white powder. The mineral acids only extract from it a little iron. Diluted ſulphuric acid, mixed with the powder, in ſuch a proportion that the maſs is not too liquid, and then evaporated to dryneſs, produces a blue coloured maſs. Before the blow-pipe does not decrepitate nor melt. It tinges microcoſmic ſalt green; but the colour becomes brown on cooling: yet microcoſmic ſalt does not diſſolve it. Soluble in borax, and alters its colour in the ſame manner.

Metallic ores.

According to the analyſis of Mr Gregor, it is compoſed of

46	oxide of iron,
45	oxide of titanium.
91	with ſome ſilica and manganeſe †.

† *M. Gregor, Jour. de Phyſ.* xxxix. 72. 152.

According to Mr Klaproth's analyſis, it is compoſed of

51.00	oxide of iron,
45.25	oxide of titanium,
3.50	ſilica,
.25	oxide of manganeſe.
100.00 ‡	

‡ *Beiträge*, ii. 231.

A mineral, nearly of the ſame nature with the one juſt deſcribed, has been found in Bavaria. Its ſpecific gravity, however, is only 3.7. According to the analyſis of Vauquelin and Hecht, it is compoſed of

49	oxide of titanium,
35	iron,
2	manganeſe,
14	oxygen combined with the iron and manganeſe.
100 §	

§ *Jour. de Min.* N° xix. 57.

285 Calcareo-ſiliceous ore of titanium.

SPECIES 3. Calcareo-ſiliceous ore of titanium.

Oxide of titanium combined with lime and ſilica—Titanite †.

† *Kirwan*, ii. 331.

This ore has hitherto been found only near Paſſau. It was diſcovered by Profeſſor Hunger. It is ſometimes maſſive, but more commonly cryſtallized in four-ſided priſms, not longer than one fourth of an inch.

Colour reddiſh, yellowiſh, or blackiſh brown; ſometimes whitiſh grey. Powder whitiſh grey. Luſtre waxy or nearly metallic, 2 to 3. Tranſparency from 0 to 2. Texture foliated. Hardneſs 9 or more. Brittle. Sp. gr. 3.510. Muriatic acid, by repeated digeſtion, diſſolves one-third of it. Ammonia precipitates from this ſolution a clammy yellowiſh ſubſtance. Infuſible by the blow pipe, and alſo in a clay crucible; but in charcoal is converted into a black opaque porous ſlag.

According to the analyſis of Klaproth, it is compoſed of

33	oxide of titanium,
35	ſilica,
33	lime.
101	

ORDER

(u) *Dolomieu, Jour. de Min.* N° XLII. 431. and *Sauſſure, Voyages*, N° 1894.

(x) *Kirw.* II. 326.—*Gregor, Jour. de Phyſ.* XXXIX. 72. and 152.—*Schmeiſſer, Crell's Annals* (Engliſh tranſlation), III. 252.

Ores of Tellurium.

Order XX. ORES OF TELLURIUM.

Hitherto tellurium has only been found in Tranſylvania. It occurs in three different mines; that of Fatzbay, Offenbanya, and Nagyag, which are conſidered as gold mines, becauſe they contain leſs or more of that metal. Its gangue is commonly quartz.

286 G. I. Alloys. White gold ore of Fatzbay.

Genus I. alloys of tellurium.

species 1. White gold ore of Fatzbay.

Alloy of tellurium and iron, with ſome gold.

This ſpecies is generally maſſive. Its colour is between tin white and lead grey. Luſtre conſiderable, metallic. Texture granular *.

According to Klaproth's analyſis, it is compoſed of

72.0 iron,
25.5 tellurium,
2.5 gold.

100.0 †

* Ann. de Chim. xxv. 327.

† Ibid. 280.

287 Graphic gloden ore of Offenbanya.

species 2. Graphic golden ore of Offenbanya.

Tellurium alloyed with gold and ſilver.

This ore is compoſed of flat priſmatic cryſtals; the arrangement of which has ſome reſemblance to Turkiſh letters. Hence the name of the ore.

Colour tin white, with a tinge of braſs yellow ‡. Luſtre metallic, 3, Hardneſs 4 to 5. Brittle. Sp. gr. 5.723. Before the blow-pipe decrepitates, and melts like lead. Burns with a lively brown flame and diſagreeable ſmell, and at laſt vaniſhes in a white ſmoke, leaving only a whitiſh earth ‖.

According to Klaproth's analyſis it is compoſed of

60 tellurium,
30 gold,
10 ſilver.

100 §

‡ Ann. de Chim. xxv. 328.

‖ De Born, Kirwan's Min. ii. 110.

The yellow gold ore of Nagyag would belong to this ſpecies were it not that it contains lead. Its compoſition, according to Klaproth's anaylſis, is as follows:

45.0 tellurium,
27.0 gold,
19.5 lead,
8.5 ſilver,

100.0 and an atom of ſulphur *.

§ Ann. de Chim. xxv. 280.

* Ibid.

288 Grey foliated gold ore of Nagyag.

species 3. Grey foliated gold ore of Nagyag.

This ore is found in plates, of different degrees of thickneſs, adhering to one another, but eaſily ſeparable: theſe are ſometimes hexahedral, and often accumulated ſo as to leave cells between them.

Colour deep lead grey, paſſing to iron black, ſpotted. Luſtre metallic, moderate. Texture foliated; leaves ſlightly flexible †. Hardneſs 6. Sp. gr. 8.919. Stains the fingers. Soluble in acids with effervefcence ‡.

According to Klaproth, it is compoſed of

50.0 lead,
33.0 tellurium,
8.5 gold,
7.5 ſulphur,
1.0 ſilver and copper.

100.0 §

† Klaproth, Ann. de Chim. xxv. 329.

‡ De Born, Kirwan's Min. ii. 99.

§ Ann. de Chim. ibid. 280.

Metallic Ores.

Order XXI. ORES OF CHROMUM.

Chromum has hitherto been found in too ſmall quantities for its extenſive application to the arts. Whenever it becomes plentiful, its properties will render it of great importance both to the dyer and painter. Nature has uſed it to colour ſome of her moſt beautiful mineral productions: And can art copy after a better model? Hitherto it has been found only in two places, near Ekaterinbourg in Siberia, and in the department of the Var in France. In the firſt of theſe places, and probably alſo in the ſecond, its gangue is quartz.

289 G. I. Salts. Chromat of lead.

Genus I. salts of chromum.

species 1. Chromat of lead.

Red lead ore of Siberia.

This ſingular mineral, which has now become ſcarce, is found in the gold mines of Bereſof near Ekaterimbourg in Siberia, cryſtallized in four-ſided priſms, ſometimes terminated by four-ſided pyramids, ſometimes not.

Colour red, with a ſhade of yellow. Streak and powder a beautiful orange yellow. Luſtre from 2 to 3. Tranſparency 2 to 3. Structure fo liated. Texture compact. Fracture uneven. Hardneſs 5 to 4. Sp. gr. 6.0269 † to 5.75 ‡. Does not effervefce with acids. Before the blow-pipe decrepitates; ſome lead is reduced, and the mineral is converted to a black ſlag, which tinges borax green.

† Briſſon.

‡ Bindheim.

According to the analyſis of Vauquelin, it is compoſed of

65.12 oxide of lead,
34.88 chromic acid.

100.00 ‖.

‖ Jour. de Min. No xxxiv. 760.

290 Chromat of iron.

species 2. Chromat of iron.

This mineral, which has been found only near Gaſſin in the department of Var in France, is in irregular meſſas.

Colour brown, not unlike that of brown blende. Luſtre metallic. Hardneſs moderate. Sp. gr. 4.0326. Melts with difficulty before the blow-pipe; to borax it communicates a dirty green. Inſoluble in nitric acid. Melted with potaſs, and diſſolved in water, the ſolution aſſumes a beautiful orange yellow colour.

It is compoſed of 63.6 chromic acid,
36.0 oxide of iron.

99.6 †

† Taſſaert, Ann. de Chim. xxxi. 220.

Chap. V. Of the Chemical Analysis of Minerals.

291 Analyſis of minerals.

The progreſs which the art of analyſing minerals has made within theſe laſt twenty years is truly aſtoniſhing. To ſeparate five or ſix ſubſtances intimately combined together, to exhibit each of them ſeparately, to aſcertain the preciſe quantity of each, and even to detect the preſence and the weight of ſubſtances which do not approach $\frac{1}{100}$th part of the compound, would, at no very remote period, have been conſidered as a hopeleſs, if not an impoſſible, taſk; yet this can now be done with the moſt rigid accuracy.

292 Begun by Margraff.

The firſt perſon who undertook the analyſis of minerals was Margraff of Berlin. His attempts were indeed rude; but their importance was ſoon perceived by other chemiſts, particularly by Bergman and Scheele,

whose industry and address brought the art of analysing minerals to a considerable degree of perfection.

But their methods, though they had very considerable merit, and, considering the state of the science, are wonderful proofs of the genius of the inventors, were often tedious and uncertain, and could not in all cases be applied with confidence.

293 Improved by Klaproth

These defects were perceived by Mr Klaproth of Berlin, who applied himself to the analysis of minerals with a persevering industry which nothing could fatigue, and an ingenuity and accuracy which nothing could perplex. He corrected what was wrong, and supplied what was wanting, in the analytical method; invented new processes, discovered new instruments; and it is to his labours, more than to those of any other chemist, that the degree of perfection, to which the analysis of minerals has attained, is to be ascribed.

294 And other chemists.

Many improvements, however, were introduced by other chemists, especially by Mr Vauquelin, whose analyses in point of accuracy and ingenuity rival those of Klaproth himself.

We shall, in this chapter, give a short description of the most perfect method of analysing minerals, as far as we are acquainted with it. We shall divide the chapter into four sections. In the first, we shall give an account of the instruments used in analyses; in the second, we shall treat of the method of analysing stones; in the third, of analysing combustibles; and in the fourth, of the analyses of ores.

Sect. I. *Of the Instruments of Analyses.*

295 Method of obtaining chemical agents pure.

I. The chymical agents, by means of which the analysis of minerals is accomplished, ought to be prepared with the greatest care, because upon their purity the exactness of the operation entirely depends. These agents are the three alkalies, both pure and combined with carbonic acid; the sulphuric, nitric, and muriatic acids; hydrosulphuret of potass and sulphurated hydrogen gas dissolved in water; prussic alkali, and a few neutral salts.

1. Potass and soda may be obtained pure, either by means of alcohol, or by the method described in the article Chemistry, n° 372. *Suppl.* These alkalies are known to be pure when their solution in pure water occasions no precipitate in lime and barytic water; when the precipitate which it produces in a solution of silver is completely dissolved by nitric acid; and, lastly, when saturated with carbonic acid it deposits no silica.

2. Ammonia is procured by distilling one part of muriat of ammonia with two parts of quicklime, and receiving the gas in a dish containing a quantity of pure water, equal in weight to the muriat employed. Its purity is known by the same tests which ascertain the purity of fixed alkalies.

3. The carbonats of potass and soda may be formed by dissolving the potass and soda of commerce in pure water, saturating the solution with carbonic acid, and crystallizing them repeatedly. When pure, these crystals effloresce in the air; and the precipitate which they occasion in solutions of barytes and of silver is completely soluble in nitric acid. Carbonat of ammonia is obtained by distilling together one part of muriat of ammonia and two parts of carbonat of lime.

4. The sulphuric acid of commerce often contains nitric acid, potass, lead &c. It may be purified by distillation in a low cucurbite. The first portion, when it comes over, must be set aside; it contains the nitric acid. The other impurities remain behind in the cucurbite. Sulphuric acid, when pure, dissolves indigo without altering its colour, does not attack mercury while cold, and causes no precipitate in pure alkaline solutions.

5. Nitric acid often contains both sulphuric and muriatic acids. It is easily purified by throwing into it about three parts of litharge in fine powder for every 100 parts of the acid, allowing the mixture to remain for 24 hours, shaking it occasionally, and then distilling it. The sulphuric and muriatic acids combine with the lead, and remain behind in the retort. Pure nitric acid occasions no precipitate in the solutions of barytes and silver.

6. The muriatic acid of commerce usually contains sulphuric acid, oxymuriatic acid, and oxide of iron. It may be purified by distillation with a little muriat of soda; taking care to set aside the first portion which comes over. When pure it causes no precipitate in the solution of barytes, nor of pure alkalies, and does not attack mercury while cold.

7. Hydrosulphuret of potass is made by saturating a solution of pure potass with sulphurated hydrogen gas; and water may be saturated with sulphurated hydrogen gas in the same manner. See Chemistry, n° 857. *Suppl.*

8. The method of preparing prussic alkali, oxalic acid, and the other substances used in analyses, has been already described in the article Chemistry, *Suppl.* it is unnecessary therefore to repeat it here.

II. Before a mineral is submitted to analysis, it ought to be reduced to an impalpable powder. This is by no means an easy task when the stone is extremely hard. 296 How to reduce the mineral to powder.

It ought to be raised to a bright red or white heat in a crucible, and then instantly thrown into cold water. This sudden transition makes it crack and break into pieces. If these pieces are not small enough, the operation may be repeated on each till they are reduced to the proper size. These fragments are then to be beaten to small pieces in a polished steel mortar; the cavity of which should be cylindrical, and the steel pestle should fit it exactly, in order to prevent any of the stone from escaping during the act of pounding. As soon as the stone is reduced to pretty small pieces, it ought to be put into a mortar of rock crystal or flint, and reduced to a coarse powder. This mortar should be about four inches in diameter, and rather more than an inch in depth. The pestle should be formed of the same stone with the mortar, and care should be taken to know exactly the ingredients of which this mortar is composed. Klaproth's mortar is of flint. We have given its analysis in n° 32. of this article.

When the stone has been reduced to a coarse powder, a certain quantity, whose weight is known exactly, 100 grains for instance, ought to be taken and reduced to as fine a powder as possible. This is best done by pounding small quantities of it at once, not exceeding 10 grains. The powder is as fine as possible when it feels soft, adheres together, and as it were forms a cake under the pestle. It ought then to be weighed exactly. It will almost always be found heavier after being pounded than it was before; owing to a certain quantity of the substance of the mortar which has been rubbed off during the grinding and mixed with the powder.

der. This additional weight muft be carefully noted; and after the analyfis, a portion of the ingredients of the mortar, correfponding to it, muft be fubtracted.

297 Chemical difhes.

III. It is neceffary to have a crucible of pure filver, or, what is far preferable, of platinum, capable of holding rather more than feven cubic inches of water, and provided with a cover of the fame metal. There fhould alfo be ready a fpatula of the fame metal about four inches long.

The difhes in which the folutions, evaporations, &c. are performed, ought to be of glafs or porcelain. Thofe of porcelain are cheaper, becaufe they are not fo apt to break. Thofe which Mr Vauquelin ufes are of porcelain; they are fections of fpheres, and are glazed both within and without, except that part of the bottom which is immediately expofed to the fire.

Sect. II. *Analyfis of Stones* (y).

298 Ingredients of ftones.

The only fubftances which enter into the compofition of the fimple ftones, as far at leaft as analyfis has difcovered, are the fix earths, filica, alumina, zirconia, glucina, lime, and magnefia; and the oxides of iron, manganefe, nickel, chromum, and copper (z). Seldom more than four or five of thefe fubftances are found combined together in the fame ftone: we fhall fuppofe, however, in order to prevent unneceffary repetitions, that they are all contained in the mineral which we are going to analyfe.

259 Method of decompofing ftones.

Let 100 or 200 grains of the ftone to be analyfed, previoufly reduced to a fine powder, be mixed with three times its weight of pure potafs and a little water, and expofed in the filver or platinum crucible to a ftrong heat. The heat fhould at firft be applied flowly, and the matter fhould be conftantly ftirred, to prevent the potafs from fwelling and throwing any part out of the crucible. When the whole water is evaporated, the mixture fhould be kept for half an hour or three quarters in a ftrong red heat.

If the matter in the crucible melts completely, and appears as liquid as water, we may be certain that the ftone which we are analyfing confifts chiefly of filica; if it remains opaque, and of the confiftence of pafte, the other earths are moft abundant; if it remains in the form of a powder, alumina is the prevalent earth. If the matter in the crucible be of a dark or brownifh red colour, it contains oxide of iron; if it is grafs green, manganefe is prefent; if it is yellowifh green, it contains chromum.

When the crucible has been taken from the fire and wiped on the outfide, it is to be placed in a capfule of porcelain, and filled with water. This water is to be renewed from time to time till all the matter is detached from the crucible. The water diffolves a part of the combination of the alkali with the filica and alumina of the ftone; and if a fufficient quantity were ufed, it would diffolve the whole of that combination.

Muriatic acid is now to be poured in till the whole of the matter is diffolved. At firft a flaky precipitate appears, becaufe the acid combines with the alkali which kept it in folution. Then an effervefcence takes place, owing to the decompofition of fome carbonat of potafs formed during the fufion. At the fame time the flaky precipitate is rediffolved; as is alfo that part of the matter which, not having been diffolved in the water, had remained at the bottom of the difh in the form of a powder. This powder, if it confifts only of filica and alumina, diffolves without effervefcence; but if it contains lime, an effervefcence takes place.

If this folution in muriatic acid be colourlefs, we may conclude that it contains no metallic oxide, or only a very fmall portion; if its colour be purplifh red, it contains manganefe; orange red indicates the prefence of iron; and golden yellow the prefence of chromum.

This folution is to be poured into a capfule of porcelain, covered with paper, and evaporated to drynefs in a fand bath. When the evaporation is drawing towards its completion, the liquor affumes the form of jelly. It muft then be ftirred conftantly with a glafs or porcelain rod, in order to facilitate the difengagement of the acid and water, and to prevent one part of the matter from being too much, and another not fufficiently dried. Without this precaution, the filica and alumina would not be completely feperated from each other.

300 How the filica is feparated.

When the matter is reduced almoft to a dry powder, a large quantity of pure water is to be poured on it; and, after expofure to a flight heat, the whole is to be poured on a filter. The powder which remains upon the filter is to be wafhed repeatedly, till the water with which it has been wafhed ceafes to precipitate filver from its folutions. This powder is the whole of the *filica* which the ftone that we are analyfing contained. It muft firft be dried between folds of blotting paper, then heated red hot in a platinum or filver crucible, and weighed while it is yet warm. It ought to be a fine powder, of a white colour, not adhering to the fingers, and entirely foluble in acids. If it be coloured, it is contaminated with fome metallic oxide; and fhews, that the evaporation to drynefs has been performed at too high a temperature. To feparate this oxide, the filica muft be boiled with an acid, and then wafhed and dried as before. The acid folution muft be added to the water which paffed through the filter, and which we fhall denominate A.

The watery folution A is to be evaporated till its quantity does not exceed 30 cubic inches, or nearly an Englifh pint. A folution of carbonat of potafs is then to be poured into it till no more matter precipitates. It ought to be boiled a few moments to enable all the precipitate to fall to the bottom. When the whole of the precipitate has collected at the bottom, the fupernatant liquid is to be decanted off; and water being fubftituted in its place, the precipitate and water are to be thrown upon a filter. When the water has run off, the filter with the precipitate upon it is to be placed between folds of blotting paper. When the precipitate has acquired fome confiftence, it is to be carefully collected by an ivory knife, mixed with a folution of pure potafs, and boiled in a porcelain capfule. If any alumina

(y) Part of this fection is to be confidered as an abftract of a treatife of Vauquelin on the analyfis of ftones, publifhed in the *Annales de Chimie*, Vol. XXX. p. 66.

(z) Barytes has alfo been difcovered in one fingle ftone, the *ftaurolite*; but its prefence in ftones is fo uncommon, that it can fcarcely be looked for. The method of detecting it fhall be noticed afterwards.

alumina or glucina be preſent, they will be diſſolved in the potaſs; while the other ſubſtances remain untouched in the form of a powder, which we ſhall call B.

301 And the alumina,

Into the ſolution of potaſs as much acid muſt be poured as will not only ſaturate the potaſs, but alſo completely rediſſolve any precipitate which may have at firſt appeared. Carbonat of ammonia is now to be added in ſuch quantity that the liquid ſhall taſte of it. By this addition the whole of the alumina will be precipitated in white fleaks, and the glucina will remain diſſolved, provided the quantity of carbonat of ammonia uſed be not too ſmall. The liquid is now to be filtered, and the alumina which will remain on the filter is to be waſhed, dried, heated red hot, and then weighed. To ſee if it be really alumina, diſſolve it in ſulphuric acid, and add a ſufficient quantity of ſulphat or acetite of potaſs; if it be alumina, the whole of it will be converted into cryſtals of alum.

302 Glucina,

Let the liquid which has paſſed through the filter be boiled for ſome time, and the glucina, if it contains any, will be precipitated in a light powder, which may be dried and weighed. When pure, it is a fine, ſoft, very light, taſteleſs powder, which does not concrete when heated, as alumina does.

303 Lime,

The reſiduum B may contain lime, magneſia, and one or more metallic oxides. Let it be diſſolved in weak ſulphuric acid, and the ſolution evaporated to dryneſs. Pour a ſmall quantity of water on it. The water will diſſolve the ſulphat of magneſia, and the metallic ſulphats; but the ſulphat of lime will remain undiſſolved. Let it be heated red hot in a crucible, and weighed. The lime amounts to 0.41 of the weight.

Let the ſolution containing the remaining ſulphats be diluted with a large quantity of water, let a ſmall exceſs of acid be added, and then let a ſaturated carbonat of potaſs be poured in. The oxides of chromum, iron, and nickel, will be precipitated, and the magneſia and oxide of mangane ſe will remain diſſolved. The precipitate we ſhall call C.

304 Mangane ſe,

Into the ſolution let a ſolution of hydroſulphuret of potaſs be poured, and the mangane ſe will be precipitated in the ſtate of a hydroſulphuret. Let it be calcined in contact with air, and weighed. The magneſia

305 Magneſia,

may then be precipitated by pure potaſs, waſhed, expoſed to a red heat, and then weighed.

306 Chromum,

Let the reſiduum C be boiled repeatedly with nitric acid, then mixed with pure potaſs; and after being heated, let the liquid be decanted off. Let the precipitate, which conſiſts of the oxides of iron and nickel, be waſhed with pure water; and let this water be added to the ſolution of the nitric acid and potaſs. That ſolution contains the chromum converted into an acid. Add to this ſolution an exceſs of muriatic acid, and evaporate till the liquid aſſumes a green colour; then add a pure alkali: The chromum precipitates in the ſtate of an oxide, and may be dried, and weighed.

307 Iron,

Let the precipitate, conſiſting of the oxides of iron and nickel, be diſſolved in muriatic acid; add an exceſs of ammonia: the oxide of iron precipitates. Let it be waſhed, dried, and weighed.

308 And nickel.

Evaporate the ſolution, and the oxide of nickel will alſo precipitate; and its weight may be aſcertained in the ſame manner with the other ingredients.

The weights of all the ingredients obtained are now to be added together, and their ſum-total compared with the weight of the matter ſubmitted to analyſis. If the two are equal, or if they differ only by .03 or .04 parts, we may conclude that the analyſis has been properly performed: but if the loſs of weight be conſiderable, ſomething or other has been loſt. The analyſis muſt therefore be repeated with all poſſible care. If there is ſtill the ſame loſs of weight, we may conclude that the ſtone contains ſome ſubſtance, which has either evaporated by the heat, or is ſoluble in water.

309 Method of detecting volatile bodies.

A freſh portion of the ſtone muſt therefore be broken into ſmall pieces, and expoſed in a porcelain crucible to a ſtrong heat. If it contains water, or any other volatile ſubſtance, they will come over into the receiver; and their nature and weight may be aſcertained.

If nothing comes over into the receiver, or if what comes over is not equal to the weight wanting, we may conclude that the ſtone contains ſome ingredient which is ſoluble in water.

310 Method of aſcertaining whether ſtones contain potaſs

To diſcover whether it contains *potaſs*, let the ſtone, reduced to an impalpable powder, be boiled five or ſix times in ſucceſſion, with very ſtrong ſulphuric acid, applying a pretty ſtrong heat towards the end of the operation, in order to expel the exceſs of acid; but taking care that it be not ſtrong enough to decompoſe the ſalts which have been formed.

Water is now to be poured on, and the reſiduum, which does not diſſolve, is to be waſhed with water till it becomes taſteleſs. The watery ſolution is to be filtered, and evaporated to dryneſs, in order to drive off any exceſs of acid which may be preſent. The ſalts are to be again diſſolved in water; and the ſolution, after being boiled for a few moments, is to be filtered and evaporated to a conſiſtence proper for cryſtallizing. If the ſtone contains a ſufficient quantity of alumina, and if potaſs be preſent, cryſtals of alum will be formed; and the quantity of potaſs may be diſcovered by weighing them, it being nearly $\frac{1}{10}$th of their weight. If the ſtone does not contain alumina, or not in ſufficient quantity, a ſolution of pure alumina in ſulphuric acid muſt be added. Sometimes the alum, even when potaſs is preſent, does not appear for ſeveral days, or even weeks; and ſometimes, when a great quantity of alumina is preſent, if the ſolution has been too much concentrated by evaporation, the ſulphat of alumina prevents the alum from cryſtallizing at all. Care, therefore, muſt be taken to prevent this laſt ſource of error. The alum obtained may be diſſolved in water, and barytic water poured into it as long as any precipitate forms. The liquor is to be filtered, and evaporated to dryneſs. The reſiduum will conſiſt of potaſs and a little carbonat of potaſs. The potaſs may be diſſolved in a little water. This ſolution, evaporated to dryneſs, gives us the potaſs pure; which may be examined and weighed.

311 Or ſoda.

If no cryſtals of alum can be obtained, we muſt look for ſome other ſubſtance than potaſs. The ſtone, for inſtance, may contain ſoda. The preſence of this alkali may be diſcovered by decompoſing the ſolution in ſulphuric acid, already deſcribed, by means of ammonia. The liquid which remains is to be evaporated to dryneſs, and the reſiduum is to be calcined in a crucible. By this method, the ſulphat of ammonia will be volatilized, and the ſoda will remain. It may be rediſſolved in water, cryſtallized, and examined.

If ſulphuric acid does not attack the ſtone, as is often the caſe, it muſt be decompoſed by fuſion with ſoda,

da, in the ſame manner as formerly directed with potaſs. The matter, after fuſion, is to be diluted with water, and then ſaturated with ſulphuric acid. The ſolution is to be evaporated to dryneſs, the reſiduum again diſſolved in water, and evaporated. Sulphat of ſoda will cryſtallize firſt; and by a ſecond evaporation, if the ſtone contains potaſs and alumina, cryſtals of alum will be depoſited.

The preſence of potaſs may be diſcovered, by mixing with a ſomewhat concentrated ſolution of muriat of platinum, the ſalt obtained, either by decompoſing the ſtone immediately by an acid, or by ſaturating with an acid the matter obtained by fuſing the ſtone with ſoda. If any potaſs be preſent, a very red precipitate will be formed. This precipitate is a triple ſalt, compoſed of potaſs, muriatic acid, and oxide of platinum. Ammonia, indeed, produces the ſame precipitate; but ammonia has not hitherto been diſcovered in ſtones.

312 Analyſis of ſaline ſtones, In this manner may ſimple ſtones and aggregates be analyſed. As to ſaline ſtones, their analyſis muſt vary according to the acid which they contain. But almoſt all of them may be decompoſed by one or other of two methods; of each of which we ſhall give an example.

I. Analyſis of Carbonat of Strontites.

313 Of Carbonats, Klaproth analyſed this mineral by diſſolving 100 parts of it in diluted muriatic acid: during the ſolution, 30 parts of carbonic acid eſcaped. The ſolution cryſtallized in needles, and when diſſolved in alcohol, burnt with a purple flame. Therefore it contained ſtrontites. He diſſolved a grain of ſulphat of potaſs in ſix ounces of water, and let fall into it three drops of the muriatic ſolution. No precipitate appeared till next day. Therefore the ſolution contained no barytes; for if it had, a precipitate would have appeared immediately.

He then decompoſed the muriatic acid ſolution, by mixing it with carbonat of potaſs. Carbonat of ſtrontites precipitated. By the application of a ſtrong heat, the carbonic acid was driven off. The whole of the earth which remained was diſſolved in water. It cryſtallized; and when dried, weighed 69½ *.

* *Klaproth's Beiträge*, i. 260.

II. Analyſis of Sulphat of Strontites.

Mr Vauquelin analyſed an impure ſpecimen of this mineral as follows:

314 Sulphats, On 200 parts of the mineral, diluted nitric acid was poured. A violent effervefcence took place, and part of the mineral was diſſolved. The undiſſolved portion, after being heated red hot, weighed 167. Therefore 33 parts were diſſolved.

The nitric ſolution was evaporated to dryneſs: A reddiſh ſubſtance remained, which indicated the preſence of oxide of iron. This ſubſtance was rediſſolved in water, and ſome ammonia mixed with it; a reddiſh precipitate appeared, which, when dried, weighed 1, and was oxide of iron. The remainder of the ſolution was precipitated by carbonat of potaſs. The precipitate weighed, when dried, 20, and poſſeſſed the properties of carbonat of lime. Therefore 200 parts of this mineral contain 20 of carbonat of lime, 1 of oxide of iron, and the remainder of the 33 parts he concluded to be water.

The 167 parts, which were inſoluble in nitric acid, were mixed with 500 parts of carbonat of potaſs, and 7000 parts of water, and boiled for a conſiderable time. The ſolution was then filtered, and the reſiduum waſhed and dried. The liquid ſcarcely effervefced with acids; but with barytes it produced a copious precipitate, totally indiſſoluble in muriatic acid. Therefore it contained ſulphuric acid.

The undiſſolved reſiduum, when dried, weighed 129 parts. It diſſolved completely in muriatic acid. The ſolution cryſtallized in needles; when diſſolved in alcohol, it burnt with a purple flame; and, in ſhort, had all the properties of muriat of ſtrontites. Therefore theſe 129 parts were carbonat of ſtrontites. Now, 100 parts of this carbonat contain 30 of carbonic acid; therefore 129 contain 38.7. Therefore the mineral muſt contain in 200 parts 90.3 of ſtrontites.

Now, the inſoluble reſiduum of 167 parts was pure ſulphat of ſtrontites; and we have ſeen that it contained 90.3 of ſtrontites. Therefore the ſulphuric acid muſt amount to 76.7 parts *.

* *Jour. de Min.* N° xxxvii. p. 1.

Nearly in the ſame manner as in the firſt of theſe examples, may the analyſis of carbonat of lime and barytes be performed; and nearly in the ſame manner with the ſecond, we may analyſe the ſulphats of lime and barytes.

Phoſphat of lime may be diſſolved in muriatic acid, and the lime precipitated by ſulphuric acid, and its quantity aſcertained by decompoſing the ſulphat of lime obtained. The liquid ſolution may be evaporated to the conſiſtence of honey, mixed with charcoal powder, and diſtilled in a ſtrong heat. By this means phoſphorus will be obtained. The impurities with which the phoſphat may be contaminated will partly remain undiſſolved, and be partly diſſolved, in muriatic acid. They may be detected and aſcertained by the rules laid down in the ſecond ſection of this chapter. 315 Phoſphats,

The fluat of lime may be mixed with ſulphuric acid and diſtilled. The fluoric acid will come over in the form of gas, and its weight may be aſcertained. What remains in the retort, which will conſiſt chiefly of ſulphat of lime, may be analyſed by the rules already laid down. 316 Fluats,

The borat of lime may be diſſolved in nitric or ſulphuric acid. The ſolution may be evaporated to dryneſs, and the boracic acid ſeparated from the reſiduum by means of alcohol, which will diſſolve it without acting on any of the other ingredients. The remainder of the dry maſs may be analyſed by the rules laid down in Sect. II. of this Chapter. 317 And borats.

SECT. III. *Of the Analyſis of Combuſtibles.*

The only combuſtibles of whoſe analyſis it will be neceſſary to ſpeak are coals and ſulphur; for the method of analyſing the diamond and oil has already been given in the article CHEMISTRY, *Suppl.*

Coal is compoſed of carbon, bitumen, and ſome portion of earth. The earths may be detected by burning completely a portion of the coal to be analyſed. The aſhes which remain after incineration conſiſt of the earthy part. Their nature may be aſcertained by the rules laid down in Sect. II. of this Chapter. 318 Earths of coal how examined.

For the method of aſcertaining the proportion of carbon and bitumen in coal, we are indebted to Mr Kirwan.

When nitre is heated red hot, and charcoal is thrown on it, a violent detonation takes place; and if the quantity of charcoal be ſufficient, the nitre is completely decompoſed. Now, it requires a certain quantity of pure 319 Method of detecting the relative proportions of charcoal and bitumen.

carbon

Analysis of Minerals.

carbon to decompose a given weight of nitre. From the experiments of Lavoisier, it follows that, when the detonation is performed in close vessels under water, 13.21 parts of charcoal are capable of decomposing 100 parts of nitre *. But when the detonation is performed in an open crucible, a smaller proportion of charcoal is necessary, because part of the nitre is decomposed by the action of the surrounding air. Scheele found that under these circumstances 10 parts of plumbago were sufficient to decompose 96 parts of nitre, and Mr Kirwan found that nearly the same quantity of charcoal was sufficient for producing the same effect.

Macquer long ago observed, that no volatile oily matter will detonate with nitre, unless it be previously reduced to a charcoal; and that then its effect upon nitre is precisely proportional to the charcoal which it contains †. Mr Kirwan, upon trying the experiment with *vegetable pitch* and *maltha*, found that these substances did not detonate with nitre, but merely burn upon its surface with a white or yellow flame; and that after they were consumed, nearly the same quantity of charcoal was necessary to decompose the nitre which would have been required if no bitumen had been used at all ‡. Now coals are chiefly composed of charcoal and bitumen. It occurred therefore to Mr Kirwan, that the quantity of charcoal which any coal contains may be ascertained by detonating it with nitre: For since the bitumen of the coal has no effect in decomposing nitre, it is evident that the detonation and decomposition must be owing to the charcoal of the coal; and that therefore the quantity of coal necessary to decompose a given portion of nitre will indicate the quantity of carbon which it contains: and the proportion of charcoal and earth which any coal contains being ascertained, its bituminous part may be easily had from calculation.

The crucible which he used in his experiments was large: it was placed in a wind furnace at a distance from the flue, and the heat in every experiment was as equal as possible. The moment the nitre was red hot, the coal, previously reduced to small pieces of the size of a pin head, was projected in portions of one or two grains at a time, till the nitre would no longer detonate; and every experiment was repeated several times to ensure accuracy.

He found that 480 grains of nitre required 50 grains of Kilkenny coal to decompose it by this method. Therefore 10 grains would have decomposed 96 of nitre; precisely the quantity of charcoal which would have produced the same effect. Therefore Kilkenny coal is composed almost entirely of charcoal.

Cannel coal, when incinerated, left a residuum of 3.12 in the 100 parts of earthy ashes. 66.5 grains of it were required to decompose 480 grains of nitre; but 50 parts of charcoal would have been sufficient: therefore 66.5 grains of cannel coal contain 50 grains of charcoal, and 2.08 of earth; the remaining 14.42 grains must be bitumen. In this manner may the composition of any other coal be ascertained.

320 Method of analysing sulphur.

As for sulphur, in order to ascertain any accidental impurities with which it may be contaminated, it ought to be boiled in thirty times its weight of water, afterwards in diluted muriatic acid, and lastly in diluted nitro-muriatic acid. These substances will deprive it of all its impurities without acting on the sulphur itself, at least if the proper cautions be attended to. The sulphur may then be dried and weighed. The deficiency in weight will mark the quantity of the substances which contaminate the sulphur. The solutions may be evaporated and examined, according to the rules laid down in the second and fourth sections of this chapter.

* Mem. Sçav. Etrang. xi. 626.

† Macquer's Dictionary, 2d edit. p. 481.

‡ Mineralogy, ii. 522.

Sect. IV. *Of the Analysis of Ores.*

THE method of analysing ores must vary considerably, according to the metals which they are suspected to contain. A general method, therefore, of analysing would be of no use, even if it could be given, because it would be too complicated ever to be practised. We shall content ourselves with exhibiting a sufficient number of the analysis of ores, to take in most of the cases which can occur. He who wishes for more information on the subject, may consult the treatise of Bergman on the *Analyses of Ores*; Mr Kirwan's treatise on the same subject; and, above all, he ought to study the numerous analyses of ores which have been published by Mr Klaproth. 321 No general method of analysing ores.

I. Analysis of Red Silver Ore.

Mr Vauquelin analysed this ore as follows: 322 Method of analysing red silver ore.

He reduced 100 parts of it to fine powder, poured over it 500 parts of nitric acid previously diluted with water, and applied a gentle heat to the mixture. The colour of the powder, which before the mixture with nitric acid was a deep purple, became gradually lighter, till at last it was pure white. During this change no nitrous gas was extricated; hence he concluded, that the metals in the ore were in the state of oxides.

When the nitric acid, even though boiled gently, did not appear to be capable of dissolving any more of the powder, it was decanted off, and the residuum, after being carefully washed, weighed 42.06.

Upon these 42.06 parts concentrated muriatic acid was poured; and by the application of heat, a considerable portion was dissolved. The residuum was repeatedly washed with muriatic acid, and then dried. Its weight was 14.6666. One portion of these 14.6666 parts, when thrown upon burning coals, burnt with a blue flame and sulphureous smell. Another portion sublimed in a close vessel without leaving any residuum. In short, they had all the properties of sulphur. Therefore 100 parts of red silver ore contain 14.6666 of sulphur.

The muriatic acid solution was now diluted with a great quantity of water; it became milky, and deposited a white flaky powder, which when washed and dried weighed 21.25. This powder, when heated with tartar in a crucible, was converted into a bluish white brittle metal, of a foliated texture, and possessing all the other properties of antimony. Red silver ore, therefore contains 21.25 of oxide of antimony.

The solution in nitric acid remained now to be examined. When muriatic acid was poured into it, a copious white precipitate appeared, which, when washed and dried, weighed 72.66. It had all the properties of muriat of silver. According to Mr Kirwan's tables, 72.66 of muriat of silver contain 60.57 of oxide of silver. Therefore red silver ore, according to this analysis, is composed of

60.57	oxide of silver,
21.25	oxide of antimony,
14.66	sulphur.
96.48	

The

Analysis of Minerals. The loss, which amounts to 3.52 parts, is to be ascribed to unavoidable errors which attend such experiments.

II. Antimoniated Silver Ore.

323 Analysis of antimoniated silver ore. Klaproth analysed this ore as follows:

On 100 parts of the ore, reduced to a fine powder, he poured diluted nitric acid, raised the mixture to a boiling heat, and after pouring off the acid, added new quantities repeatedly, till it would dissolve nothing more. The residuum was of a greyish yellow colour, and weighed, when dry, 26.

These 26 parts he digested in a mixture of nitric and muriatic acid; part was dissolved, and part still remained in the form of a powder. This residuum, when washed and dried, weighed 13 parts. It had the properties of sulphur; and when burnt, left a residuum of one part, which had the properties of silica. Antimoniated silver ore, therefore, contains, in the 100 parts, 12 parts of sulphur and 1 of silica.

When the nitro-muriatic solution was diluted with about 20 times its weight of water, a white precipitate appeared; which, when heated to redness, became yellow. Its weight was 13. No part evaporated at a red heat: therefore it contained no arsenic. On burning coals, especially when soda was added, part was reduced to a metal, having the properties of antimony; and in a pretty high heat, the whole evaporated in a grey smoke. These 13 parts were therefore oxide of antimony: They contain about 10 parts of metallic antimony; and as the state of oxide was produced by the action of the nitric acid, we may conclude that antimoniated silver ore contains 10 parts of antimony.

The nitric acid solution remained still to be examined. It was of a green colour. When a solution of common salt was poured in, a white precipitate was obtained, which possessed the properties of muriat of silver. When dried, it weighed 87.75 parts; and when reduced, 65.81 parts of pure silver were obtained from it. Antimoniated silver ore, therefore, contains 65.81 of silver.

Into the nitric acid solution, thus deprived of the silver, he dropped a little of the solution of sulphat of soda; but no precipitate appeared. Therefore it contained no lead.

He supersaturated it with pure ammonia, on which a grey precipitate appeared. When dried, it weighed 5 parts. This, on burning coals, gave out an arsenical smell. It was redissolved in nitric acid; sulphurated alkali occasioned a smutty brown precipitate; and prussic alkali a prussian blue, which, after torrefaction, was magnetic. Hence he concluded, that these five parts were a combination of iron and arsenic acid.

The nitric solution, which had been supersaturated with ammonia, was blue; he therefore suspected that it contained copper. To discover this, he saturated it with sulphuric acid, and put into it a polished plate of iron. The quantity of copper was so small, that none could be collected on the iron.

III. Grey Copper Ore.

314 Analysis of grey copper ore. Klaproth analysed this ore as follows:

Three hundred grains of it, not completely freed from its matrix, were reduced to a fine powder; four times their weight of nitric acid was poured on them, and the whole was digested. The acid was then poured off, and an equal quantity again digested on the residuum. The two acid solutions were mixed together. The residuum was of a yellowish grey colour, and weighed 188 grains.

On this residuum six times its weight of muriatic acid was boiled. The residuum was washed, first with muriatic acid, and afterwards with alcohol, and the washings added to the muriatic acid solution. The residuum, when dried, weighed 105.5 grains. Part of it burned with a blue flame; and was therefore sulphur. The residuum amounted to 80.25 grains, and had the properties of silica. When melted with black flux, about $\frac{3}{4}$ths of a grain of silver were obtained from it. Thus 300 parts of grey copper ore contain 25.25 gr. of sulphur, and 79.5 of silica.

The muriatic acid solution, which was of a light yellow colour, was concentrated by distillation, a few crystalls of muriat of silver appeared in it, which contained about $\frac{1}{4}$th grain of silver. The solution, thus concentrated, was diluted with a great quantity of water; a white precipitate was deposited, which, when dried, weighed 97.25 grains. It possessed the properties of oxide of antimony, and contained 75 grains of antimony. Therefore 300 grains of grey copper ore contain 70 of antimony.

The nitric acid solution was of a clear green colour. A solution of common salt occasioned a white precipitate, which was muriat of silver, and from which 31.5 grains of silver were obtained.

A little sulphat of potass, and afterwards sulphuric acid, were added, to see whether the solution contained lead; but no precipitate appeared.

The solution was then supersaturated with ammonia; a loose fleaky brownish red precipitate appeared, which, when heated to redness, became brownish black, and weighed $9\frac{1}{4}$th grains. This precipitate was dissolved in muriatic acid; half a grain of matter remained undissolved, which was silica. The muriatic acid solution, when prussic alkali was added, afforded a blue precipitate; and soda afterwards precipitated 1.5 grains of alumina. Therefore 300 grains of grey copper ore contain 7.25 grains of iron, and 1.5 of alumina.

Into the nitric solution supersaturated with ammonia, and which was of an azure blue colour, a polished plate of iron was put: By this method 69 grains of copper were obtained.

IV. Sulphuret of Tin.

Klaproth analysed this ore as follows *:

325 Analysis of sulphuret of tin. On 120 grains of the ore reduced to powder, six times their weight of nitro-muriatic acid, composed of 2 parts of muriatic, and 1 of nitric acid, were poured. There remained undissolved 43 grains, which had the appearance of sulphur; but containing green spots, was suspected not to be pure. After a gentle combustion, 13 grains remained; 8 of which were dissolved in nitro-muriatic acid, and added to the first solution. The remaining 5 were separated by the filtre, and heated along with wax. By this method about a grain of matter was obtained, which was attracted by the magnet; and which therefore was iron. The residuum weighed 3 grains, and was a mixture of alumina and silica. Thus 120 grains of sulphuret of tin contain 30 grains of sulphur, 1 of iron, and 3 of alumina and silica.

* *Observations on the Fossils of Cornwall*, p. 48.

The

Analyfis of Minerals.

The nitro-muriatic folution was completely precipitated by potafs. The precipitate was of a greyifh green colour. It was wafhed and dried, and again diffolved in diluted muriatic acid. Into the folution a cylinder of pure tin was put, which weighed exactly 217 grains. The folution became gradually colourlefs, and a quantity of copper precipitated on the cylinder of tin, which weighed 44 grains. To fee whether it was pure, a quantity of nitric acid was digefted on it; the whole was diffolved, except one grain of tin. Therefore 120 grains of fulphuret of tin contains 43 grains of copper.

The cylinder of tin now weighed only 128 grains; fo that 89 grains had been diffolved. Into the folution a cylinder of zinc was put; upon which a quantity of tin precipitated. When wafhed and dried, it weighed 130 grains. The tin he melted with tallow and powdered charcoal; and when cold, he wafhed off the charcoal. Among the tin globules were found fome black flocculi of iron, which weighed one grain. Deducting this grain, and the 89 grains of the tin cylinder which had been diffolved, we fee that the 120 grains of fulphuret of tin contained 40 grains of tin befides the grain which had been detected in the copper.

V. Plumbiferous Antimoniated Silver Ore.

326 Analyfis of plumbiferous antimoniated filver ore.

Klaproth analyfed this ore as follows:

He digefted 400 grains of it, reduced to a fine powder, firft in five times its weight of nitric acid, and then in twice its weight of the fame acid. He then diluted this laft portion of acid with eight times its weight of water, and continued the digeftion. The undiffolved refiduum, when wafhed and dried, weighed 326 grains.

On this refiduum he boiled muriatic acid repeatedly. The folution, on cooling, depofited acicular cryftals. Thefe he carefully feparated, and put by. The undiffolved refiduum weighed 51 grains. It had the properties of fulphur. When burned, it left one grain of filica.

The muriatic acid folution was concentrated to half its former bulk by diftillation: this made it depofite more acicular cryftals. He continued the diftillation as long as any cryftals continued to appear. He then collected the whole of thefe cryftals together. They had the properties of muriat of lead. When mixed with twice their weight of black flux, and heated in a crucible lined with charcoal, they yielded $160\frac{1}{8}$ grains of lead.

Sulphuret of ammonia was now added to the muriatic acid folution; an orange-coloured precipitate appeared, which fhewed that the folution contained antimony. It was precipitated by a copious effufion of water, and by foda. The oxide of antimony being reduced to a mafs with Spanifh foap, mixed with black flux, and heated in a lined crucible, yielded 28.5 grains of antimony.

Into the nitric acid folution, obtained by the firft part of the procefs, a folution of muriat of foda was dropped; a white precipitate was depofited, and over it acicular cryftals. Thefe cryftals he diffolved, by pouring boiling water on the precipitate. The water was added to the nitric acid folution. The white precipitate was muriat of filver: when heated with twice its weight of foda, it yielded 81.5 grains of filver.

He now concentrated the nitric acid folution by evaporation; and then adding a folution of fulphat of foda, a white precipitate was obtained, which had the properties of fulphat of lead, and weighed 43 grains. It contained 32 grains of pure lead.

Analyfis of Minerals.

He now poured ammonia into the folution; a pale brown precipitate was obtained, which weighed 40 grains, and which appeared to confift of oxide of iron and alumina. He rediffolved it in nitric acid, precipitated the iron by pruffic alkali, and the alumina by foda. The alumina, after being heated to rednefs, weighed 28 grains; confequently the oxide of iron was 12 grains, which is equivalent to 9 grains of iron.

VI. Molybdat of Lead.

Mr Hatchett analyfed this ore as follows*:

On 250 grains of the ore, reduced to a fine powder, he poured an ounce of ftrong fulphuric acid, and digefted the mixture in a ftrong heat for an hour. When the folution was cool, and had fettled, he decanted it off, and wafhed the undiffolved powder with pure water, till it came away taftelefs. This operation was repeated twice more; fo that three ounces of fulphuric acid were ufed. All thefe folutions were mixed together, and filtered. 327

327 Analyfis of molybdat of lead.

Four ounces of a folution of carbonat of foda were poured upon the powder which remained undiffolved, and which confifted of fulphat of lead. The mixture was boiled for an hour, and then poured off. The powder was then wafhed, and diluted nitric acid poured on it: The whole was diffolved, except a little white powder, which, when wafhed, and dried on a filter by the heat of boiling water, weighed feven-tenths of a grain. It poffeffed the properties of filica.

The nitric acid folution was faturated with pure foda; a white precipitate was obtained, which, when wafhed, and dried for an hour in a heat rather below rednefs, weighed 146 grains. It poffeffed the properties of oxide of lead.

To fee whether this oxide of lead contained any iron, it was diffolved in diluted nitric acid, and the lead precipitated by fulphuric acid. The folution was then faturated with ammonia; a brown powder precipitated, which, when dried, weighed one grain, and had the properties of oxide of iron.

The fulphuric acid folution was of a pale blue colour: It was diluted with 16 times its weight of pure water, and then faturated with ammonia. It became of a deep blue colour, and appeared turbid. In 24 hours a pale yellow precipitate fubfided, which, when collected on a filter, and dried by a boiling water heat, weighed 4.2 grains. Its colour was yellowifh brown. Muriatic acid diffolved it, and pruffiat of potafs precipitated it from its folution in the ftate of pruffian blue. It was therefore oxide of iron.

The fulphuric acid folution, faturated with ammonia, was gradually evaporated to a dry falt. This falt was a mixture of molybdat of ammonia and fulphat of ammonia. A ftrong heat was applied, and the diftillation continued till the whole of the fulphat of ammonia was driven off; and to be certain that this was the cafe, the fire was raifed till the retort became red hot. The refiduum in the retort was a black bliftered mafs; three ounces of nitric acid, diluted with water, were poured upon it, and diftilled off. The operation was again repeated.

* Phil. Tranf. lxxxvi. 320.

peated. By this method the oxide of molybdenum was converted into a yellow powder, which was yellow acid of molybdenum. It weighed 95 grains.

VII. Grey Ore of Manganefe.

Mr Vauquelin analyfed this ore as follows *.

318 Analyfis of grey ore of manganefe. When 200 grains of it were expofed to a ftrong heat in a retort, there came over 10 grains of water, and 18 cubic inches of oxygen gas, mixed with a little carbonic acid gas. The mineral now weighed only 176 grains. Therefore the weight of the gas was 14 grains.

* Jour. de Min. N° xvii. p. 12.

On 200 grains of the fame mineral muriatic acid was poured, and heat applied. 75 cubic inches of oxy-muriatic acid gas came over, which, though mixed with fome carbonic acid gas, enflamed metals when reduced to powder. When no more gas came over, the refiduum was boiled. The whole was diffolved except a white powder, which weighed 12 grains, and which poffeffed the properties of filica.

Carbonat of potafs was poured into the folution; a white precipitate was obtained, which became black by expofure to the air, and weighed 288 grains. Strong nitric acid was boiled on it repeatedly to drynefs. It became of a deep black colour, and, when well wafhed with water and dried, weighed 164 grains. This powder was black oxide of manganefe.

To fee whether it contained iron, nitric acid, with a little fugar, was poured upon it, and digefted on it. The acid diffolved it completely. Therefore no oxide of iron was prefent.

Into the water with which the black oxide of manganefe had been wafhed, carbonat of potafs was poured; a white powder precipitated, which, when dried, weighed 149 grains, and which poffeffed the properties of carbonat of lime.

VIII. Wolfram.

329 Analyfis of wolfram. Meffrs Vauquelin and Hecht analyfed this mineral as follows:

On 200 parts of Wolfram in powder, three times its weight of muriatic acid were poured, and the mixture boiled for a quarter of an hour: a yellow powder appeared, and the folution was of a brown colour. The acid was allowed to cool, and then carefully decanted off, and the refiduum wafhed. The refiduum was then digefted for fome hours with ammonia, which diffolved a part of it. The refiduum was wafhed, and new muriatic acid again poured over it; then the refiduum was digefted with ammonia, as before: and the operation was continued till the whole wolfram was diffolved.

All the ammoniacal folutions being joined together, were evaporated to drynefs, and the falt which remained was calcined: a yellow powder was obtained; it weighed 134 grains, and was yellow acid of tungften.

Into the muriatic acid folutions, which were all mixed together, a fufficient quantity of fulphuric acid was poured to decompofe all the falts. The folution was then evaporated to drynefs; and the falts which were obtained by this evaporation were rediffolved in water. A white powder remained, which weighed three grains, and which poffeffed the properties of filica.

The excefs of acid of the folution was faturated with carbonat of potafs; the liquor became brown, but nothing precipitated. When boiled, a red powder precipitated, and the brown colour difappeared. The addition of more carbonat of potafs caufed a farther precipitation of a yellowifh powder. This precipitate confifted of the oxides of iron and manganefe combined. Nitric acid was diftilled off it repeatedly; it was then boiled in acetous acid. The acetous folution was precipitated by potafs. Nitric acid was again diftilled off it, and it was again boiled in acetous acid. This procefs was repeated till nitric acid produced no further change. The different powders which could not be diffolved in the acetous acid were collected, mixed with a little oil, and heated red hot. The powder became black, and was attracted by the magnet. It was therefore oxide of iron. It weighed 36 grains.

The acetous folution contained the oxide of manganefe: It was precipitated by an alkali, and, when dried, weighed 12.5 grains.

IX. Oxide of Titanium and Iron.

Vauquelin analyfed this ore as follows: 330 Analyfis of oxide of titanium and iron.

A hundred parts of the ore, reduced to a fine powder, and mixed with 400 parts of potafs, were melted in a filver crucible for an hour and a half. When cool, the mixture was diluted with water; a powder remained of a brick red colour, which when wafhed and dried weighed 124 parts.

The watery folution had a fine green colour; when an excefs of muriatic acid was added, it became red. By evaporation the liquor loft its colour. When evaporated to drynefs, a falt remained, which was totally diffolved by water. From this folution carbonat of potafs precipitated two parts, which had the properties of oxide of manganefe.

The 124 parts of refiduum were boiled in a folution of pure potafs for an hour. The folution was faturated with an acid, filtered, and carbonat of potafs added, which precipitated three parts. Thefe had the properties of oxide of titanium.

The remainder of the 124 parts of refiduum, which ftill was undiffolved, was boiled with diluted muriatic acid. The liquor became yellow, and depofited 46 parts of a white powder, with a tint of red. This powder was foluble in fulphuric and muriatic acids: from thefe folutions, it was precipitated of a brick red colour by the infufion of nut-galls; of a green colour by fulphuret of ammonia and pruffiat of potafs; and of a white colour by carbonat of potafs and pure ammonia. A rod of tin made thefe folutions red; a rod of zinc made them violet. Thefe 46 parts therefore are oxide of titanium.

The muriatic folution, from which thefe 46 parts were depofited, formed, with pruffiat of potafs, a pruffian blue; and ammonia precipitated from it 50 parts, which had the properties of yellow oxide of iron.

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Mirabeau. MIRABEAU (Honnoré Gabriel, Compte de), well known both by his writings and the active part which he took in bringing about the French revolution, was born in 1749 of a noble family. Throughout life he displayed a spirit averse from every restraint, and was one of those unhappy geniuses in whom the most brilliant talents serve only as a scourge to themselves and all around them. It is told by his democratical panegyrists, as a wonderful proof of family tyranny under the old government, that not less than 67 *lettres de cachet* had been obtained by Mirabeau the father against this son and others of his relatives. This story, if true, proves, with at least equal force, what many anecdotes confirm, that, for his share of them, the son was not less indebted to his own ungovernable disposition than to the severity of his parent. He was indeed a monster of wickedness. Debauchery, gaming, impiety, and every kind of sensuality, were not enough for him. He was destitute of decency in his vices; and to supply his expences, scrupled not to perform tricks which would disgrace a thief-catcher. His father and mother disagreeing, commenced a process of separation; when Mirabeau, just liberated from prison for a gross misdemeanor, was in want of money. He went to his father, sided with him against his mother, on whom he poured a torrent of invectives; and, for 100 guineas, wrote his father's memorial for the court. He then went to his mother; and by a similar conduct got the same sum from her; and both memorials were presented. That the father of such a man should frequently get him shut up in prison, can excite no surprise; for confinement only could withhold him from the perpetration of crimes.

The talents of Mirabeau led him frequently to employ his pen; and his publications form the chief epochas of his life. His first publication was, 1. *Essai sur le Despotisme*, "An Essay on Despotism," in 8vo. Next, in one of his confinements, he wrote, 2. a work in two vols 8vo, *On Lettres de Cachet*. 3. *Considerations sur l'Ordre de Cincinnatus*, 8vo. A remonstrance against the order of Cincinnatus, proposed at one time to be established in America. The public opinion in America favoured this remonstrance, and it proved effectual. 4. His next work was in favour of the Dutch, when Joseph II. demanded the opening of the Sheldt, in behalf of the Brabançons. It is entitled, *Doutes sur la Liberté de l'Escant*, 8vo. 5. *Lettre à l'Empereur Joseph II. sur son Règlement concernant l'Emigration*; a pamphlet of forty pages, in 8vo. 6. *De la Caisse d'Escompte*; a volume in 8vo, written against that establishment. 7. *De la Banque d'Espagne*, 8vo; a remonstrance against establishing a French bank in Spain. A controversy

Mirabeau. controverſy ariſing upon this ſubject, he wrote again upon it. 8. Two pamphlets on the monopoly of the water company in Paris.

Soon after the publication of theſe works, he was ſent in a public character to the court of Berlin; where he conducted the king's affairs juſt as he had formerly done thoſe of his father and mother, fully ready to ſacrifice all parties, and to ſell himſelf to the higheſt bidder. With ſuch a diſpoſition, he could not long avoid the notice of the Pruſſian illuminees; and Nicolai Bieſter, Gedicke, and Leuchſenring, ſoon became his conſtant companions. At Brunſwick he met with Mauvillon, the worthy diſciple of Philo Knigg, and at that time a profeſſor in the Caroline college. This was the man who initiated the profligate Marquis in the laſt myſteries of illuminiſm.

Mirabeau was ſtill at Berlin when Frederick II. died. That monarch, as is well known, was a naturaliſt, who, holding this life for his all, encouraged the propagation of infidelity in his dominions, from which reſulted the very worſt conſequences to the peace of ſociety. Of this truth his ſucceſſor Frederick William was duly ſenſible; and determined to ſupport the church eſtabliſhment in the moſt peremptory manner, conſiſtent with the principles of religious toleration. He publiſhed, therefore, ſoon after his acceſſion, an edict on religion, which is a model worthy of imitation in every country; but it was attacked with the greateſt virulence in numberleſs publications. It was called an unjuſtifiable tyranny over the conſciences of men; the dogmas ſupported by it were termed abſurd ſuperſtitions; the king's private character and his religious opinions were ridiculed and ſcandalouſly abuſed. The moſt daring of theſe attacks was a collection of anonymous letters on the conſtitution of the Pruſſian ſtates, univerſally believed to be the compoſition of Mirabeau, who certainly wrote a French tranſlation, with a preface and notes more impudent than the work itſelf. The monarch is declared to be a tyrant; the people of the Pruſſian dominions are addreſſed as a parcel of tame wretches, crouching under oppreſſion; and the inhabitants of Silesia, repreſented as ſtill in a worſe condition, are repeatedly called upon to rouſe themſelves, and aſſert their rights.

About this time he publiſhed, 9. An *Eſſai ſur le Secte des Illuminés;* one of the ſtrangeſt and moſt impudent books that ever appeared. In it he deſcribes a ſect exiſting in Germany, called the *Illuminated;* and ſays, that they are the moſt abſurd and groſs fanatics imaginable, waging war with every appearance of reaſon, and maintaining the moſt *ridiculous ſuperſtitions.* He gives ſome account of theſe, and of their rituals and ceremonies, as if he had ſeen them all; yet no ſuch ſociety as he deſcribes ever exiſted: and Mirabeau employed his powers of deception, merely to ſcreen from obſervation the real *illuminati,* by holding out to the rulers of ſtates this *ignis fatuus* of his own brain. For a while the eſſay certainly contributed to blind the eyes of the German princes; and Nicolai, with others of the junto, adopting the whim, called Mirabeau's fanatics *Obſcuranten,* and joined with him in placing on the liſt of *Obſcuranten* ſeveral perſons whom they wiſhed to make ridiculous.

Long before his initiation in the myſteries of illuminiſm, Mirabeau had been acquainted with all the revolutionary powers of the maſonic lodges; nor did he, when initiated, undervalue thoſe which flowed, or might flow, from Weiſhaupt's inventive genius. On his return to France, he began to introduce the new myſteries among ſome of his maſonic brethren. His firſt aſſociate was the Abbe Talleyrand de Perigord, who had already begun to act the part of Judas in the firſt order of the church. But to have only introduced the myſteries was not ſufficient for the Marquis; he would have teachers come from Germany, who were better verſed than he was in the illuminizing arts. Well acquainted with the reaſons that had induced the chiefs of the order to defer the converſion of France, he found means to convince them, that the time was now come for the accompliſhment of their views; and at his requeſt a deputation was ſent by Spartacus to illuminize that great kingdom. See Illuminati, n° 40, 41, *Suppl.*

When the aſſembly of Notables was convened at Paris, Mirabeau foretold that it would ſoon be followed by a meeting of the States; and at that period he publiſhed a volume againſt the ſtockjobbing, then carried to a great height, intitled, 10. *Denonciation de l'agiotage au Roi, et a l'Aſſemblée de Notables,* 8vo. A *lettre de cachet* was iſſued againſt him in conſequence of this publication; but he eluded purſuit, and publiſhed a pamphlet as a ſequel to the book. His next work was againſt M. Necker, 11. *Lettre á M. de Cretelle, ſur l'Adminiſtration de M. Necker,* a pamphlet in 8vo. 12. A volume in 8vo, againſt the Stadtholderſhip: *Aux Bataves, ſur le Stadthouderat.* 13. *Obſervations ſur la maiſon de force appellé Bicetre,* an 8vo pamphlet. 14. Another tract, intitled, *Conſeils à un jeune Prince qui ſent la néceſſité de refaire ſon education.* 15. He now proceeded to a larger and more arduous work than any he had yet publiſhed, on the Pruſſian monarchy under Frederick the Great: *De la Monarchie Pruſſienne ſous Frederic le Grand,* 4 vols, 4to, or eight in 8vo. In this work he undertakes to define preciſely how a monarchy ſhould be conſtituted. When the orders were iſſued for convening the States-general, Mirabeau returned into Provence; and at the ſame time publiſhed, 16. *Hiſtoire Secrette de la Cour de Berlin,* two volumes of letters on the Secret Hiſtory of the Court of Berlin. This work was condemned by the parliament of Paris, for the unreſerved manner in which it delivered the characters of many foreign princes. As the elections proceeded, he offered himſelf a candidate in his own order at Aix; but he was ſo abhorred by the nobleſſe, that they not only rejected him, but even drove him from their preſence. This affront ſettled his meaſures, and he determined on their ruin. He went to the commons, diſclaimed his being a gentleman, ſet up a little ſhop in the market-place of Aix, where he ſold trifles; and now fully reſolved what line he ſhould purſue, he courted the commons, by joining in all their exceſſes againſt the nobleſſe, and was at laſt returned a member of the aſſembly.

In conſequence of this, he went to Paris; where the part he took was active, and ſuch as tended, in general, to accelerate all the violences of the revolution. He now publiſhed, periodically, 17. his *Lettres à ſes Commettans,* Letters to his Conſtituents, which form, when collected, 5 vols 8vo. It is ſuppoſed, that the fatal meaſure of the junction of the three orders into one national

Mirabeau, Miſtral. tional aſſembly, was greatly promoted by theſe letters. The public events of theſe times, and the part taken in them by Mirabeau, are the ſubject of general hiſtory. He lived to ſee the conſtitution of 1789 eſtabliſhed, but not to ſee its conſequences—the deſtruction of the monarchy, the death of the king, and the ruin of all property! He was accuſed, as well as the duke of Orleans, of hiring the mob which attacked Verſailles on the 5th and 6th of October 1789; but with him was alſo acquitted by the tribunal of the Châtelet. The dominion of his eloquence in the National Aſſembly had long been abſolute, and, on the 29th of January 1791, he was elected preſident. At the latter end of March, in the ſame year, he was ſeized by a fever, and died on the 2d of April.

The talents of Mirabeau will not be doubted, though they were certainly rather brilliant than profound. To be noticed, and to lead, were the ſole objects of his ambition; and for the attainment of them, he took the ſide of the diſcontented, as the beſt field for his matchleſs eloquence. Yet there was no man more devoted to the principles of a court than this Marquis, provided he could have a ſhare in the adminiſtration; and a ſhare he would have obtained, if any thing moderate would have ſatisfied him: But he thought nothing worthy of him but a place of active truſt, and a high department; ſtations which all knew him not qualified to fill. Wanting knowledge of great things, he was learned only in the buſtling detail of intrigue, and would, at any time, have ſacrificed his deareſt friend, and the intereſts of his country, for an opportunity of exerciſing his brilliant eloquence, and indulging his propenſity to ſatire and lampoon. But the greateſt obſtacle to his advancement under the old government was the abject worthleſſneſs of his character. Drinking was the only vice in which he did not indulge; and from this he was reſtrained by his exhauſted conſtitution. To his brother, the Viſcount, who was frequently intoxicated, the Marquis one day ſaid, "How can you, brother, ſo expoſe yourſelf? "What (replied the Viſcount)! how inſatiable are you? Nature has given you every vice; and having left me only this one, you grudge it me!

MISTRAL, the name of a wind, which is mentioned in almoſt every account that we have of Provence, and which is remarkable for blowing almoſt the whole year from north-weſt or weſt-north-weſt, in a climate where the wind ſhould be variable. It is ſaid to contribute to the ſalubrity of the air, by diſperſing the exhalations of the marſhes and ſtagnant waters, ſo common in the ſouth of Languedoc and Provence; but at times it is alſo very injurious, or at leaſt very troubleſome. It is not, however, on either of theſe accounts that it is introduced into this Work, but for the ſake of the cauſes aſſigned by Sauſſure for its conſtancy, which may be applied to other winds that nearly reſemble it; and which he found might be reduced to three.

"The firſt and moſt effectual cauſe (he ſays) is the ſituation of the Gulf of Lyons, the banks of which are the principal theatre of its ravages. This Gulf, in fact, is ſituated at the bottom of a funnel, formed by the Alps and Pyrenees. All the winds blowing from any point between weſt and north, are forced by theſe mountains to unite in the Gulf. Thus, winds which would not have prevailed but at one extremity of the Gulf, or even much beyond it, are obliged to take this route, after having undergone the repercuſſion of theſe mountains; and the middle of the Gulf, inſtead of the calm which it might have enjoyed, is expoſed to the united efforts of two ſtreams of wind, deſcending in different directions. Hence ariſe thoſe whirlwinds which ſeem to characteriſe the miſtral, and appear to have induced the ancients to call it *Circius, à turbine ejus ac vertigine*. See *Aul. Gellius*, l. ii. cap. 22.

Miſtral ‖ Mœris. "The ſecond cauſe is, the general ſlope of the grounds, deſcending from all ſides towards the Gulf; which becoming all at once lower and more ſoutherly than the lands extending behind it, is, from theſe joint circumſtances, rendered the hotteſt point of all the adjacent country: and, as the air on the ſurface of the earth always tends from the colder to the warmer regions, the Gulf of Lyons is actually the centre towards which the air from all colder points between eaſt and weſt muſt preſs. This cauſe, then, alone would be productive of winds directed to the Gulf, even if the repercuſſion of the mountains did not exert its influence.

"Finally, it is well known, that in all gulfs the land-winds blow more forcibly than oppoſite to plains and promontories, whatever be the ſituation of thoſe gulfs. I apprehend, indeed, on ſtrict examination (ſays our author), that this cauſe is blended with the preceding; but as the fact is generally admitted, and in ſome caſes can be explained only by reaſons drawn from the effects of heat, it may not improperly, perhaps, be diſtinctly mentioned. It is, at leaſt, neceſſary to ſuppoſe, that ſeveral cauſes produce the miſtral, in order to underſtand why, notwithſtanding the variableneſs of the ſeaſons and temperatures, that wind is ſo ſingularly conſtant in Lower Languedoc and Lower Provence. A very remarkable inſtance of this conſtancy is recorded by the Abbé Papon, in his *Voyage de Provence*, tom. ii. p. 81. He aſſerts, that during the years 1769 and 1770, the miſtral continued for fourteen months ſucceſſively. But the three cauſes which I have ſtated, taken ſeparately, will explain its frequency, and, united, will account for its force."

MIXT Angle, or *Figure*, is one contained by both right and curved lines.

Mixt Number, is one that is partly an integer and partly a fraction; as $3\frac{1}{2}$.

Mixt Ratio, or *Proportion*, is when the ſum of the antecedent and conſequent is compared with the difference of the antecedent and conſequent;

$$\text{as if}\left\{\begin{array}{l} 4:3::12:9 \\ a:b::c:d \end{array}\right.$$

$$\text{then}\left\{\begin{array}{l} 7:1::21:3 \\ a+b:a-b::c+d:c-d. \end{array}\right.$$

MOCASSIMAH, in Bengal, revenue ſettled by a diviſion of the produce.

MOCHULKAH, bond or obligation.

MŒRIS, a lake in Egypt, occaſionally mentioned in that article (*Encycl.*), and generally ſuppoſed the production of human art. Of this, however, Mr Brown ſays it bears no mark. "The ſhape, as far as was diſtinguiſhable, ſeems not inaccurately laid down in D'Anville's map, unleſs it be, that the end neareſt the Nile ſhould run more in a north-weſt and ſouth-eaſt direction. The length may probably be between 30 and 40 miles; the breadth, at the wideſt part he could gain, was 5000 toiſes, as taken with a ſextant; that is, nearly

ly fix miles. The utmoft poffible extent of circuit muft of courfe be 30 leagues. On the north-eaft and fouth is a rocky ridge, in every appearance primeval. In fhort, nothing can prefent an appearance more unlike the works of men. Several fifhermen, in miferable boats, are conftantly employed on the lake. The water is brackifh, like moft bodies of water under the fame circumftances. It is, in the language of the country, *Birket-el-kerun*, probably from its extremities bearing fome refemblance to horns.

MOFUSSEL, a relative term, fignifying the fubordinate lands or diftricts, oppofed to SUDDER, which is the head.

MOHACZ, MOHATZ, or *Mohoz*, a town in the Lower Hungary, upon the Danube, between the river Sarwizu to the north, and the Drave to the fouth; four German miles from either, fix from Effeck to the north, and nine from Colocoa to the fouth. This otherwife fmall place is memorable for two great battles here fought; the firft between Lewis king of Hungary and Solyman the Magnificent, in 1526: in which that unfortunate Prince Lewis (being about 20 years old), with 25,000 men, fought 300,000 Turks; when, being overpowered by numbers, 22,000 of the Chriftian army were flain upon the place; 5000 waggons, eighty great cannon, 600 fmall ones, with all their tents and baggage, were taken by the victors; and the King, in his flight over the brook Curafs, fell into a quagmire, and was fwallowed up. After which, Solyman took and flew 200,000 Hungarians, and got fuch a footing in that kingdom, that he could never be expelled. This fatal battle was fought October 29. The fecond, in fome part, retrieves the lofs and infamy of the former. The Duke of Loraine being fent by the Emperor, with exprefs orders to pafs the Drave and take Effeck, his highnefs, July 10, 1687, with great difficulty paffed that river, then extremely fwelled with rains; but finding the Prime Vifier encamped at Effeck, with an army of 100,000 men, fo ftrongly, that it was not poffible to attack him in that poft without the ruin of the Chriftian army, he retreated, and repaffed it the 23d of the fame month; where, upon the 29th, the Prime Vifier paffed that river at Effeck; and upon Auguft 12th, there followed a bloody fight, in which the Turks loft 100 pieces of cannon, 12 mortars, all their ammunition, provifion, tents, baggage, and treafure, and about 8000 men upon the place of battle, befides what were drowned in paffing the river, which could never be known. After which victory, General Dunewalt, September 30th, found Effeck totally deferted by the Turks, and took poffeffion of it.

MOHER, in Bengal, a gold coin, worth about 33 fhillings.

MOHERIR, a writer of accounts.

MOINEAU, a flat baftion raifed before a curtin when it is too long, and the baftions of the angles too remote to be able to defend one another. Sometimes the moineau is joined to the curtin, and fometimes it is divided from it by a moat. Here mufquetry are placed to fire each way.

MOLE (See TALPA, *Encycl.*), is an animal exceedingly troublefome, both to gardeners and farmers; and there are perfons who contrive to make a livelihood by the trade of *mole-catching*. Thefe men, it is well known, are generally quacks and cheats; and the fecrets which they fell for extirpating thofe deftructive animals are of very little avail. Even poifon feldom produces any confiderable effect; becaufe the mole, while it does not drink, lives only on roots and worms. Under the word MOLE (*Encycl.*), fome directions will be found for clearing fields of this deftructive animal; but the following are perhaps preferable, as they feem to have been the refult of much experience:

Immediately at day-break, it will be neceffary to make a tour round the garden or meadow, from which it is wifhed to extirpate the moles; for at that time they will be all found at work, as may be feen by the hills newly thrown up. If the perfon is then clofe to the hill, he muft proceed as the gardeners do, and turn up with a ftroke of the fpade the hill together with the digger. The paffage is then cut through before the animal is aware of the attack; and therefore it has not power to efcape. If the mole-hill be frefh, even though the animal may not be throwing up earth, the perfon ought not to lofe his time in waiting, but fhould immediately proceed to the operation above-mentioned.

If you find a frefh hill ftanding by itfelf, which feems to fhew by its fituation that it has no communication with any other, which is always the cafe when the mole has worked from the furface downwards in endeavouring to procure a more convenient habitation, after the hill has been turned up with the fpade, a bucket of water fhould be poured over the mouth of the paffage. By thefe means the animal, which is at no great diftanc, will be obliged to come forth, and may be eafily caught with the hand.

You may difcover alfo whether a hill has any communication with another, if you apply your ear to it, and then cough or make a loud noife. If it has no communication with the neighbouring hills, you will hear the terrified animal make a noife by its motion. It will then be impoffible for it to efcape; and you may either pour water into the hole, or turn up the hill with a fpade, until the mole is found; for, in general, it never goes deeper into the earth than from fifteen to eighteen inches.

When any of the beds in a garden have been newly watered, the mole, attracted by the coolnefs and moifture, readily repairs thither, and takes up its refidence in them, making a paffage at the depth of fcarcely an inch below the furface. In that cafe it may eafily be caught. When you fee it at work, you need only tread behind the animal with your feet on the paffage to prevent its retreat, and then turn up the hill with a fpade; by which means you will be fure to catch it.

When you dig after it with a fpade, the animal forces its way downwards into the earth in a perpendicular direction, in order that it may the better efcape the threatened danger. In that cafe it will not be neceffary to dig long, but to pour water over the place, which will foon make the animal return upwards.

People, in general, are not aware of the great mifchief occafioned in fields and gardens by thefe animals. We are, however, informed by Buffon, that in the year 1740 he planted fifteen or fixteen acres of land with acorns, and that the greater part of them were in a little time carried away by the moles to their fubterranean retreats. In many of thefe there were found half a bufhel, and in others a bufhel. Buffon, after this circumftance, caufed a great number of iron traps to be conftructed;